CHAPTER 6

Conclusion

Foodborne diseases are a major health and economic problem in both industrialized and developing countries. Policy-makers should recognize that the nutritional well-being of the population depends as much on availability of and access to nutritious food as on food safety (Box 27). The prevention of foodborne diseases through health education in food safety is both possible and cost-effective.

Box 27. The importance of food safety for human nutrition (*FAO/WHO International Conference on Nutrition, 1992*)

The causes of nutritional problems are broad, and eliminating malnutrition and overnutrition is not merely a matter of increasing or altering food supplies. Rather, the causes of nutritional problems are likely to be complex, and interdependent, and clearly extend to food quality and safety.

In view of the size of the task, solving the food safety problem may not be easy, particularly in many developing countries with limited resources. However, it should be realized that education is a powerful and practical means of improving public health both substantially and sustainably. Education has a lasting effect in preventing foodborne diseases by stimulating individuals and communities to want safe food, to appreciate food hazards, to learn how to control them and to observe the principles of food safety. Education enables people to make informed choices.

The public health sector has a crucial role to play in food safety education. In cooperation with other governmental sectors (such as tourism, education, agriculture, municipalities) and nongovernmental sectors (such as industry, universities, research institutes, consumer groups, religious groups), the public health sector should develop and implement a programme for the education of food handlers and the general public. This could include:

— development and dissemination of educational materials for consumers;
— implementation of food safety education campaigns and programmes using mass media and other channels of communication;
— establishment of a consumer affairs bureau where consumers can obtain answers to their queries;
— integration of food safety into the primary health care programme, with specific emphasis on the education of mothers (or other persons looking after small children) and vulnerable groups;

— integration of food safety into the curricula of primary and secondary schools;
— integration of food safety into training curricula for health workers and nutritionists;
— integration of food safety into the curricula of hotel and restaurant schools;
— mandatory education and training of professional food handlers, particularly managers of food service establishments;
— dissemination of information on high-risk foods to travellers;
— training and education of street food vendors in the basic rules of food safety.

It is hoped that this book will make a positive contribution to the quest for increased health education in food safety.

ANNEX 1

Foodborne illnesses: some facts and figures

The following tables provide concise information about the epidemiology of foodborne diseases and how they can be prevented. The tables give the name (and alternative names) of foodborne illnesses, together with the following information about each of them:

- the codes by which the illness is classified in the International Classification of Diseases, 9th and 10th revisions (ICD-9 and ICD-10);
- the etiological agent that causes the illness;
- the main characteristics of the etiological agent;
- the incubation period of the illness;
- the symptoms;
- the possible sequelae of the illness;
- the duration of the illness;
- the reservoir or source of the etiological agent;
- the mode of transmission of the agent, together with examples of foods that have been involved in outbreaks;
- measures that can be taken to control/prevent the spread of the etiological agent (by industry, by professional and domestic food handlers, and by consumers);
- the occurrence of the illness, as indicated by + (less than 1 case per 100 000 population), ++ (1–100 cases per 100 000 population) and +++ (over 100 cases per 100 000 population);
- the geographical occurrence of the illness;
- other details about the nature of the illness or about the agent that causes it.

The diseases are listed in alphabetical order by type of pathogen, with bacteria first, then viruses and then parasites (protozoa, nematodes, cestodes, trematodes).

Type of illness	***Aeromonas* enteritis**
Etiological agent	Bacterium: *Aeromonas hydrophila*.
Characteristics of the agent	Gram-negative, motile, non-spore-forming, facultatively anaerobic, straight or curved rods that will not grow in 4–5% salt or at pH < 6. Optimum growth temperature is 28 °C, but growth may occur at lower temperatures, down to 4 °C. Many strains have the ability to grow over a wide pH range (4–10) under otherwise optimal conditions.
Incubation period	24–48 hours.
Symptoms	Watery stools, stomach cramps, mild fever and vomiting.
Sequelae	Bronchopneumonia, cholecystitis.
Duration	Days–weeks.
Reservoir/source	A common organism found in aquatic environments that has been isolated from a wide range of foods.
Mode of transmission and example of foods involved in outbreaks	Seafood (fish, shrimp, oysters), snails, drinking-water.
Specific control measures	*Industrial:* treatment and disinfection of water supplies, food irradiation. *Food service establishment/household:* thorough cooking of food, no long-term refrigeration of ready-to-eat foods.
Occurrence	Worldwide. Sporadic outbreaks have been reported from Africa, Australia, Europe, Japan and North America. Estimated rate of occurrence: unknown.
Other comments	Opportunistic pathogen.

Type of illness	***Bacillus cereus* gastroenteritis** a) Diarrhoeal syndrome b) Emetic syndrome
ICD code	ICD-9: 005.8 ICD-10: A05.4
Etiological agent	Bacterial toxin: a) Diarrhoeal syndrome due to production of heat-labile toxins either in the gut or in food. b) Emetic syndrome due to heat-stable toxins produced in food.
Characteristics of the agent	Gram-positive, facultatively anaerobic, motile rods which produce heat-resistant spores; generally mesophilic, growing between 10 °C and 50 °C, with the optimum at 28–37 °C (there are, however, psychrotrophic strains which grow at 4 °C). They will grow in a pH range of 4.3–9.3 and water activity (a_w) above 0.92. Spores are moderately heat-resistant, and survive freezing and drying. Some strains require heat activation for spores to germinate and outgrow.
Incubation period	a) Diarrhoeal syndrome: 8–16 hours. b) Emetic syndrome: 1–5 hours.
Symptoms	a) Diarrhoeal syndrome: acute diarrhoea, nausea and abdominal pain. b) Emetic syndrome: acute nausea, vomiting and abdominal pain and sometimes diarrhoea.
Duration	a) Diarrhoeal syndrome: 24–36 hours. b) Emetic syndrome: 24–36 hours.
Reservoir/source	Widely distributed in nature (soil).
Mode of transmission and example of foods involved in outbreaks	Ingestion of food that has been stored at ambient temperatures after cooking, permitting the growth of bacterial spores and production of toxin. Many outbreaks (particularly those of emetic syndrome) are associated with cooked or fried rice that has been kept at ambient temperature. Examples of foods involved include starchy products, such as boiled or fried rice, spices, dried foods, milk and dairy products, vegetable dishes and sauces.
Specific control measures	*Food service establishment/household:* Effective temperature control to prevent spore germination and growth: food storage at >60 °C or properly refrigerated at <10 °C until use, unless other factors such as pH or a_w are such as to prevent growth. When refrigeration facilities are not available, cook only quantities required for immediate consumption. Toxins associated with emetic syndrome are heat-resistant and reheating, including stir frying, will not destroy them.
Occurrence	Worldwide. Estimated rate of occurrence: ++/+++.

Type of illness	**Botulism**
ICD code	ICD-9: 005.1 ICD-10: A05.1
Etiological agent	Bacterial toxin: toxins of *Clostridium botulinum*.
Characteristics of the agent	Gram-positive, spore-forming, obligately anaerobic, motile rods which produce seven potent neurotoxins A–G; only A, B, E and, infrequently, F have been associated with disease (*Clostridium botulinum*). Group G is named *Clostridium argentinense*. The toxins are potentially lethal in very small doses. They act by binding at the neuromuscular junction, blocking nerve transmission and causing flaccid paralysis. Proteolytic strains of *C. botulinum* producing toxin types A, B and F are mesophilic, growing over the range 10–50 °C. Non-proteolytic strains producing toxin types B, E and F are psychrotrophic and can grow at temperatures as low as 3.3 °C. Minimum water activity for growth is 0.93–0.94 and minimum pH for growth is 4.6 (proteolytic strains) or 5.0 (non-proteolytic strains). The toxin is heat-labile and can be destroyed by adequate heat treatment (boiling for 15 minutes). Spores are resistant to normal cooking temperatures, and survive drying and freezing.
Incubation period	Generally 12–36 hours, but may range from a few hours to 8 days.
Symptoms	Vomiting, abdominal pain, fatigue, muscle weakness, headache, dizziness, ocular disturbance (blurred or double vision, dilated pupils, unreactive to light), constipation, dry mouth and difficulty in swallowing and speaking leading ultimately to paralysis and respiratory or heart failure.
Duration	From days up to 8 months; treatment is normally the rapid administration of antitoxin, alkaline stomach washing and mechanical respiratory support.
Reservoir/source	Soil, marine and freshwater sediments and the intestinal tracts of fish, animals, birds and insects.
Mode of transmission and example of foods involved in outbreaks	Ingestion of toxin pre-formed in the food. This may occur when raw or under-processed foods are stored in conditions (temperature, a_w, pH and atmosphere) allowing for growth of the organism. Most outbreaks are due to faulty preservation of food (particularly in homes or cottage industries), e.g. canning, fermentation, curing, smoking, acid or oil preservation. Examples of foods involved include vegetables, condiments (e.g. pepper), fish and fish products (type E), meat and meat products. Several outbreaks have occurred as a result of consumption of uneviscerated fish, garlic in oil

	and baked potatoes. Honey is suspected as a mode of transmission of infant botulism.
Specific control measures	The toxin is destroyed by boiling; however, spores require a much higher temperature. *Industrial:* heat sterilization; use of nitrites in pasteurized meat. *Food service establishment/household:* acid-preservation of food at a low pH (<4.6); thorough cooking of home-canned food (boil and stir for 15 minutes); refrigerated storage of food, particularly vacuum-packed, fresh or lightly cured/smoked food. *Consumers* should avoid giving honey or foods containing honey to infants, and discard swollen cans.
Occurrence	Worldwide; particularly frequent among Alaskan populations due to faulty fermentation. Estimated rate of occurrence: +.
Other comments	Case-fatality rate in industrialized countries is in the range 5–10%. In infants, toxicoinfection, infant botulism, may occur and honey is a suspected source.

Type of illness	**Brucellosis (undulant fever)**
ICD code	ICD-9: 023 ICD-10: A23
Etiological agent	Bacteria: a) *Brucella abortus* b) *Brucella melitensis* c) *Brucella suis*.
Characteristics of the agent	Gram-negative, aerobic, non-spore-forming, short, oval, non-motile rods which grow optimally at 37 °C; heat-labile. Optimum pH for growth: 6.6–7.4.
Incubation period	Variable, from a few days to several weeks or months.
Symptoms	Continuous, intermittent or irregular fever, lassitude, sweat, headache, chills, constipation, body pain, weight loss and anorexia.
Sequelae	Bouts of fever, osteoarticular complications in 20–60% of cases, sacroiliitis, genitourinary complications (including orchitis, epididymitis, sexual impotence), cardiovascular and neurological conditions, insomnia, depression.
Duration	Weeks.
Reservoir/source	Cows, goats, pigs, sheep. a) *Brucella abortus*: cows. b) *Brucella melitensis*: sheep and goats. c) *Brucella suis*: pigs.
Mode of transmission and example of foods involved in outbreaks	Contracted principally from close association with infected animals and therefore an occupational disease of farmers, herdsmen, veterinarians and slaughterhouse workers. It can also be contracted by consumption of milk (usually goat's or sheep's milk), and products made from unpasteurized milk, e.g. fresh goat cheese.
Specific control measures	*Industrial:* heat treatment of milk (pasteurization or sterilization), use of pasteurized milk for cheese production, ageing cheese for at least 90 days. *Food service establishment/household:* heat treatment of milk (boiling). *Other:* vaccination of animals; eradication of diseased animals (testing and slaughtering). *Consumers* should avoid drinking raw milk and eating cheese made with raw milk.

Occurrence	Worldwide, with the exception of parts of northern Europe where it occurs rarely. Incidence in North America is decreasing. Currently reported incidence in the USA is below 120 cases per year. Prevalent in eastern Mediterranean areas, southern Europe, North and East Africa, Central and Southern Asia (India), Central and South America (e.g. Mexico). Estimated rate of occurrence depending on the region: + or ++.
Other comments	The disease is often unrecognized and unreported. Susceptible to antibiotic treatment. Case-fatality rate may be up to 2% if the disease is untreated.

Type of illness	**Campylobacteriosis**
ICD code	ICD-9: 008.4 ICD-0: A04.5
Etiological agent	Bacteria: *Campylobacter jejuni* and *Campylobacter coli.*
Characteristics of the agent	Gram-negative, non-spore-forming, curved or spiral, motile rods which are sensitive to oxygen and grow best at low oxygen levels in the presence of carbon dioxide. Optimum pH 6.5–7.5. They will not grow below 28–30 °C, grow optimally at 42–45 °C and are very sensitive to heat, salting, reduced pH levels (<6.5) and dry conditions. The organism survives better in chilled conditions than at ambient temperature.
Incubation period	1–11 days, most commonly 2–5 days.
Symptoms	Fever, severe abdominal pain, nausea, and diarrhoea which can vary from slight to profuse watery diarrhoea sometimes containing blood or mucus.
Sequelae	Sequelae may occur in 2–10% of cases. These include reactive arthritis, Guillain-Barré syndrome, haemolytic uraemic syndrome, meningitis, pancreatitis, cholecystitis, colitis, endocarditis, erythema nodosum.
Duration	Up to 10 days; excretion of the organism can continue for 2–3 weeks.
Reservoir/source	Domestic animals (cats, dogs), livestock (pigs, cattle, sheep), birds (poultry), polluted water.
Mode of transmission and example of foods involved in outbreaks	Principally through ingestion of contaminated food. Main food sources are raw milk and raw or undercooked poultry. The bacteria can be spread to other foods by cross-contamination, or contamination with untreated water, contact with animals and birds. Other sources of transmission are contact with live animals (pets and farm animals, e.g. chickens). Person-to-person transmission can also occur during the infectious period which ranges from several days to several weeks. Examples of foods involved include raw milk, poultry, beef, pork and drinking-water.
Specific control measures	*Industrial:* heat treatment (pasteurization/sterilization of milk); hygienic slaughter and processing procedures, irradiation of meat and poultry; treatment of water. *Food service establishment/household:* heat treatment of milk (boiling); thorough cooking of all meat; washing of salads; prevention of cross-contamination of contact surfaces; personal hygiene in food preparation (hand-washing after contact with animals); keeping pets away from food-handling areas.

	Consumers should avoid eating raw or partially cooked poultry and drinking raw milk.
Occurrence	Worldwide. This is one of the most frequently reported foodborne diseases in industrialized countries. In developing countries it is a major cause of infant and traveller's diarrhoea. Some 10-15% of cases of diarrhoeal disease in children, seen at treatment centres, are caused by *Campylobacter* spp. Estimated rate of occurrence: ++/+++ in industrialized and developing countries respectively.
Other comments	Many infections are asymptomatic. Infected individuals not treated with antibiotics may excrete the organisms for as long as 2-7 weeks. Infection is sometimes misdiagnosed as appendicitis. More sporadic cases occur in the warmer months. The case-fatality rate in industrialized countries is about 0.05%. Infants and young children are the most susceptible.

Type of illness	**Cholera**
ICD code	ICD-9: 001 ICD-10: A00
Etiological agent	Bacteria: *Vibrio cholerae* 01 (enterotoxin in the gut). Two biotypes are distinguished: classical and eltor. These are further divided into Ogawa and Inaba serotypes. Also, *Vibrio cholerae* 0139.
Characteristics of the agent	Gram-negative, facultatively anaerobic, motile, non-spore-forming rods which grow at 18–42 °C and optimally at 37 °C. Will grow down to a_w 0.97 and over a pH range of 6–11; optimum pH is 7.6. Growth is stimulated by salinity levels of around 3% but is prevented at 6%. The organisms are resistant to freezing but sensitive to heat and acid and may survive for some days on fruit and vegetables. *V. cholerae* is non-invasive and diarrhoea is mediated by cholera toxin formed in the gut.
Incubation period	1–3 days.
Symptoms	Profuse watery diarrhoea, which can lead to severe dehydration, collapse and death within a few hours unless lost fluid and salt are replaced; abdominal pain and vomiting.
Duration	Up to 7 days.
Reservoir/source	Humans. *V. cholerae* is often found in aquatic environments and is part of the normal flora in brackish water and estuaries.
Mode of transmission and example of foods involved in outbreaks	Food and water contaminated through contact with faecal matter of infected food handlers. Contamination of vegetables may occur through sewage or wastewater used for irrigation. Person-to-person transmission through the faecal–oral route is also important. Examples of foods involved include seafood, vegetables, cooked rice, and ice.
Specific control measures	*Industrial*: control measures include safe disposal of excreta and sewage/wastewater; treatment of drinking-water, e.g. chlorination; irradiation, heat treatment of foods, e.g. canning. *Food service establishment/household:* personal hygiene (washing hands with soap and water); thorough cooking of food and careful washing of fruit and vegetables; boiling drinking-water when safe water is not available.

	Consumers should avoid eating raw seafood. In some countries, travellers may need to be vaccinated.
Occurrence	Africa, Asia, parts of Europe and Latin America. In most industrialized countries, reported cholera cases are imported by travellers, or occur as a result of import of food by travellers.
Other comments	In endemic areas, cholera occurs mainly in children because of lack of prior immunity; in epidemics children and adults are equally susceptible. Case-fatality rate can be less than 1% with adequate treatment; in untreated cases, the case-fatality rate may exceed 50%. Estimated rate of occurrence: in industrialized countries cholera occurs rarely and is mainly imported. In Africa and Central and South Africa +/++, and in other parts of the world +.

Type of illness	***Clostridium perfringens* enteritis**
ICD code	ICD-9: 005.2 ICD-10: A05.2
Etiological agent	Bacterium: *Clostridium perfringens* (produces enterotoxin in the gut), also known as *Clostridium welchii*.
Characteristics of the agent	Gram-positive, non-motile, anaerobic, spore-forming rods that will grow in the temperature range 12–50 °C, although very slowly below 20 °C. They grow extremely quickly at optimum temperature 43–47 °C. Optimum pH is between 6 and 7, but growth will occur as low as pH 5. Lowest a_w supporting growth is 0.95.
Incubation period	8–24 hours.
Symptoms	Abdominal pain and diarrhoea. Vomiting and fever are rare.
Duration	1–2 days.
Reservoir/source	Soil, sewage, dust, faeces of animals and humans, animal-origin feedstuffs.
Mode of transmission and example of foods involved in outbreaks	Illness is usually caused by cooked meat and poultry dishes subject to time-temperature abuse (i.e. exposure of food to time/temperature conditions permitting bacterial proliferation or not sufficient for reduction of the contaminant(s) to safe levels). The dish has usually been left too long at ambient temperature for cooling before storage, or cooled inadequately. This allows spores surviving the cooking process to germinate and grow, producing large numbers of vegetative cells. If the dish is not reheated sufficiently before consumption to kill the vegetative cells then illness can result. Examples of foods involved include meat and poultry (boiled, stewed).
Specific control measures	*Food service establishment/household:* adequate cooling and cool storage of cooked products: meat-based sauces and large pieces of meat should be cooled to <10 °C within 2–3 hours; thorough reheating of stored food before consumption; preparation of quantities as required when there is no available refrigeration.
Occurrence	Worldwide. Estimated rate of occurrence: ++/+++.
Other comments	Case-fatality rate in industrialized countries is very low at <0.1%.

Type of illness	***Escherichia coli* infections**
ICD code	ICD-9: 008.0 ICD-10: A04.0–A04.3 (EPEC: A04.0; ETEC: A04.1, EIEC: A04.2; EHEC: A04.3)
Etiological agent	Bacteria: a) *E. coli* enteropathogenic (EPEC). b) *E. coli* enterotoxigenic (ETEC) produces two types of enterotoxins: a heat-labile toxin (LT) and a heat-stable toxin (ST). c) *E. coli* enteroinvasive (EIEC). d) *E. coli* enterohaemorrhagic (EHEC) or verocytotoxin-producing *E. coli* (VTEC).
Characteristics of the agent	Gram-negative, non-spore-forming, facultatively anaerobic rods, which belong to the family Enterobacteriaceae. Typically mesophile, the bacteria will grow from about 7–10 °C up to 50 °C, with the optimum at 37 °C; in a pH range of 4.4–8.5. Minimum a_w for growth is 0.95. Most *E. coli* spp. are harmless inhabitants of the gut of humans and other warm-blooded animals; however, the strains mentioned above may cause diseases. EHEC is more acid-resistant than other *E. coli*.
Incubation period	a) EPEC: 1–6 days; as short as 12–36 hours. b) ETEC: 1–3 days; as short as 10–12 hours. c) EIEC: 1–3 days; as short as 10–18 hours. d) EHEC: 3–8 days, with a median of 4 days.
Symptoms	a) EPEC infection: enteropathogenic *E. coli* adhere to the gut mucosa and change its absorption capacity causing vomiting, diarrhoea, abdominal pain, and fever. b) ETEC infection: health effects are mediated by enterotoxins. Symptoms include diarrhoea (ranging from mild afebrile diarrhoea to a severe, cholera-like syndrome of profuse diarrhoea without blood or mucus), abdominal cramps and vomiting, sometimes leading to dehydration and shock. c) EIEC infection: inflammatory disease of the gut mucosa and submucosa caused by the invasion and multiplication of EIEC in the epithelial cells of the colon. Symptoms include fever, severe abdominal pain, vomiting and watery diarrhoea (in <10% of cases stools may become bloody and may contain mucus). d) EHEC infection: abdominal cramps, watery diarrhoea that may develop into bloody diarrhoea (haemorrhagic colitis). Fever and vomiting may also occur.
Sequelae	EPEC, ETEC, EIEC infections are an underlying factor of malnutrition in infants and children in developing countries.

	EHEC infections may result in life-threatening complications, such as haemolytic uraemic syndrome (HUS), in up to 10% of patients, particularly young children and the elderly. HUS is characterized by acute renal failure, haemolytic anaemia and thrombocytopenia. Other sequelae include erythema nodosum and thrombotic thrombocytopenic purpura.
Duration	a) EPEC: days–weeks. b) ETEC: up to 5 days. c) EIEC: days–weeks. d) EHEC: days–weeks.
Reservoir/source	Humans are the main reservoir for EPEC, ETEC, EIEC. The reservoir for EHEC is mainly cattle.
Mode of transmission and example of foods involved in outbreaks	a–c) EPEC, ETEC, EIEC infections: consumption of food and water contaminated with faecal matter. Time–temperature abuse of such food increases the risk of illness. Up to 25% of infections in infants and young children in developing countries are due to *E. coli*, in particular ETEC and EPEC, which are observed in 10–20% and 1–5% of cases at treatment centres respectively. ETEC is also a major cause of traveller's diarrhoea in developing countries. d) EHEC infection is transmitted mainly through consumption of foods such as raw or undercooked ground-meat products, and raw milk, from infected animals. Faecal contamination of water and other foods, as well as cross-contamination during food preparation, will also lead to infection. Examples of foods involved include ground (minced) meat, raw milk, and vegetables. Secondary transmission (person-to-person) may also occur during the period of excretion which is less than a week for adults but up to 3 weeks in one-third of children affected.
Specific control measures	*Industrial:* treatment of drinking-water, and an effective sewage disposal system. *Food service establishment/household:* specific control measures based on prevention of direct and indirect contamination of food and water with faecal matter; thorough cooking and reheating of food; and good personal hygiene. For EHEC infection, control measures include: *Industrial:* irradiation of meat, or thorough heat processing of meat; pasteurization/sterilization of milk; treatment of wastewater used for irrigation. *Food service establishment/household:* thorough cooking of meat, boiling of milk or use of pasteurized milk; hand-washing before preparation of food.

	Consumers should avoid eating raw or partially cooked meat and poultry and drinking raw milk.
Occurrence	Worldwide. *E. coli* infections are highly prevalent in developing countries where the estimated rate of occurrence is +++. EHEC infections are mainly reported in Argentina, Chile, Europe (France, Germany, Italy, Sweden, UK), Japan and North America.
Other comments	The case-fatality rate of EPEC, ETEC, EIEC infections in industrialized countries is estimated to be less than 0.1%. The case-fatality rate of EHEC infection is about 2%. The fatality rate of *E. coli* infections in infants and children is much higher in developing countries. Children and the elderly are particularly vulnerable to this infection and may suffer more severely. The majority of cases of EHEC infections are reported in summer.

Type of illness	**Listeriosis**
ICD code	ICD-9: 027 ICD-10: A32
Etiological agent	Bacterium: *Listeria monocytogenes.*
Characteristics of the agent	Gram-positive, non-spore-forming, facultatively anaerobic rods. Psychrotrophic, capable of growing in a temperature range of 3–42 °C, but optimally at about 30–35 °C. The pH range for growth is 5.0–9.0. Minimum pH and a_w for growth are 4.4 and 0.92 respectively. The bacteria are able to grow in the presence of 10% salt.
Incubation period	A few days to several weeks.
Symptoms	Influenza-like symptoms such as fever, headache and occasionally gastrointestinal symptoms.
Sequelae	Meningoencephalitis and/or septicaemia in newborns and adults and abortion in pregnant women. The onset of meningoencephalitis (rare in pregnant women) may be sudden with fever, intense headaches, nausea, vomiting and signs of meningeal irritation. Delirium and coma may appear early; occasionally there is collapse and shock.
Duration	Days–weeks.
Reservoir/source	Water, soil, sewage, sludge, decaying vegetables, silage and faeces of numerous wild and domestic animals. Other sources may be infected animals and people.
Mode of transmission and example of foods involved in outbreaks	A substantial proportion of cases of listeriosis are foodborne. Examples of foods involved include raw milk, soft cheese, meat-based paste, jellied pork tongue, raw vegetables and coleslaw.
Specific control measures	*Industrial:* heat treatment of milk (pasteurization, sterilization) with measures to ensure reduction of processing contamination risks. For ready-to-eat high-risk processed foods, reduction of all cross-contamination risks after processing. *Food service establishment/household:* use of pasteurized or heat-treated (boiled) milk and products made from pasteurized or heat-treated milk; refrigeration of perishable foods and consumption within a short space of time. Pre-cooked refrigerated foods should be thoroughly reheated before consumption. Avoidance of certain high-risk foods, e.g. soft cheese, ready-to-eat meat such as meat paste, and raw milk and raw milk products during pregnancy.

	Consumers, particularly pregnant women and other vulnerable individuals, should avoid eating raw foods of animal origin, e.g. raw meat, raw milk. Pregnant women should also avoid foods which support growth of *Listeria*, e.g. soft cheese, pre-prepared salad, cold, smoked or raw seafood, paté.
Occurrence	Estimated rate of occurrence: +. The majority of cases reported have been from Europe, North America and the islands of the Pacific.
Other comments	The most severe form of illness occurs in fetuses and neonates, the elderly and those who are immunocompromised. About one-third of clinical cases occur in the newborn. In adults infection occurs mainly in those aged 40 or over. Transplacental fetal infection may lead to abortion or stillbirth. Asymptomatic infection may occur at all ages. Infected individuals may shed the organisms in their stools for several months. Case-fatality rate is up to 30%; in patients who have not received adequate treatment the case-fatality rate may be as high as 70%. Pregnant women and fetuses, the elderly, and immunocompromised individuals, including those receiving treatments for cancer, are the most susceptible.

Type of illness	**Salmonellosis**
ICD code	ICD-9: 003 ICD-10: A02.0
Etiological agent	Bacteria: non-typhoid *Salmonella* serotypes.
Characteristics of the agent	Gram-negative, mesophilic, facultatively anaerobic, motile, non-spore-forming rods. Growth can occur between 5 °C and 47 °C. Optimum growth occurs at 37 °C. Minimum pH and a_w for growth are 4 and 0.95 respectively.
Incubation period	6–48 hours, occasionally up to 4 days.
Symptoms	The principal symptoms are fever, headache, nausea, vomiting, abdominal pain and diarrhoea.
Sequelae	Reactive arthritis, septicaemia, aortitis, cholecystitis, colitis, meningitis, myocarditis, osteomyelitis, pancreatitis, Reiter disease, rheumatoid syndromes.
Duration	Usually a few days to 1 week, but sometimes infection may last up to 3 weeks.
Reservoir/source	A wide range of domestic and wild animals, including poultry, pigs, cattle, rodents, iguanas, tortoises, turtles, and pets such as dogs and cats. Also humans, i.e. patients and convalescent carriers.
Mode of transmission and example of foods involved in outbreaks	The main route of transmission is by ingestion of the organisms in food (milk, meat, poultry, eggs) derived from infected food animals. Food can also be contaminated by infected food handlers, pets and pests, or by cross-contamination owing to poor hygiene. Contamination of food and water may also occur from the faeces of an infected animal or person. Problems caused by initial contamination may be exacerbated by prolonged storage at temperatures at which the organism may grow. Direct person-to-person transmission may also occur during the course of the infection. Examples of foods involved include unpasteurized milk, raw eggs, poultry, meat, spices, salads, chocolate.
Specific control measures	*Industrial:* effective heat-processing of foods of animal origin including pasteurization of milk and eggs; irradiation of meat and poultry. *Food service establishment/household:* safe food preparation practices, including thorough cooking and reheating of food and boiling of milk; adequate refrigeration; prevention of cross-contamination, cleaning and disinfection of food preparation surfaces; exclusion of pets and other animals from food-handling areas.

	Consumers, particularly vulnerable groups, should avoid raw and undercooked meat and poultry, as well as raw milk and raw eggs and foods containing raw eggs.
Occurrence	Worldwide. Estimated rate of occurrence: ++/+++. A drastic increase in incidence of salmonellosis, due particularly to *S. enteritidis*, has occurred during the past two decades in Europe, North America and some other countries. In Europe and North America, contaminated eggs and poultry have been the major source of infection.
Other comments	General susceptibility is increased by achlorhydria, antacid therapy, immunosuppressive therapy and debilitating conditions, including malnutrition. The severity of the illness is related to serotype, the number of organisms ingested and host factors. Case-fatality rate is less than 1% in industrialized countries. Symptomless excretion of the organism can continue for several weeks or, in some cases, months.

Type of illness	**Shigellosis (or bacillary dysentery)**
ICD code	ICD-9: 004 ICD-10: A03
Etiological agent	Bacteria: *Shigella dysenteriae, S. flexneri, S. boydii, S. sonnei.*
Characteristics of the agent	Gram-negative, non-motile, non-spore-forming, facultatively anaerobic rods. Typically mesophilic: growing between 10 °C and 45 °C and optimally at 37 °C. The bacteria grow best in the pH range 6–8 and do not survive below pH 4.5. The minimum a_w for growth is 0.97.
Incubation period	1–3 days, up to 1 week for *S. dysenteriae.*
Symptoms	Abdominal pain, vomiting, fever accompanied by diarrhoea that can range from watery (*S. sonnei*) to a dysenteric syndrome of bloody stools containing mucus and pus (*S. dysenteriae* and, to a lesser extent, *S. flexneri* and *S. boydii*).
Sequelae	In 2–3% of cases these may be: haemolytic uraemic syndrome, erythema nodosum, Reiter disease, splenic abscesses, synovitis.
Duration	A few days to a few weeks.
Reservoir/source	Humans.
Mode of transmission and example of foods involved in outbreaks	Food and water contaminated with faecal matter. Person-to-person transmission through the faecal–oral route is an important mode of transmission. Food can be contaminated by food handlers with poor personal hygiene or by use of sewage/wastewater for fertilization. Examples of foods involved include uncooked foods that have received extensive handling such as mixed salads and vegetables; water and raw milk.
Specific control measures	*Industrial:* treatment of drinking-water and an effective sewage disposal system. *Food service establishment/household:* safe food preparation practices including careful hand-washing with soap and water, thorough cooking and reheating of food prior to consumption, disinfection of food preparation surfaces and thorough washing of all fruit and vegetables.
Occurrence	Worldwide, with a higher prevalence in developing countries. Shigellosis is a major cause of diarrhoea in infants and children under the age of 5 years, and constitutes 5–15% of diarrhoeal disease cases seen at treatment centres. *S. dysenteriae* type 1 has been responsible for large epidemics of severe dysentery in Central America and recently Central Africa and southern Asia.

	Depending on the degree of development the estimated rate of occurrence may vary between + and +++.
Other comments	In developing countries, *S. flexneri* is the most common cause of infection. However, *S. dysenteriae* type 1, occurring in epidemic regions, causes the most severe disease. In industrialized countries, *S. sonnei* is the most common species isolated, and milder illness is the norm. The disease is more severe in young children than in adults among whom many infections may be asymptomatic. The elderly and those suffering from malnutrition are particularly susceptible and may develop severe symptoms or even die. Travellers are particularly at risk. Case-fatality rate in industrialized countries is low and estimated at 0.1%.

Type of illness	***Staphylococcus aureus* intoxication**
ICD code	ICD-9: 005.0 ICD-10: A05.0
Etiological agent	Bacterial toxin: *Staphylococcus aureus* enterotoxin.
Characteristics of the agent	Gram-positive, non-motile, non-spore-forming, facultatively anaerobic cocci. Growth temperature is between 7 °C and 48 °C, with an optimum of about 37 °C. The bacteria grow in a pH range of 4.0–9.3. Optimum pH is 7.0–7.5. The range over which enterotoxin is produced is narrower, with little toxin production below pH 6.0. Growth will occur down to an a_w of 0.83, but toxin production does not occur below 0.86. This is the most resistant bacterial pathogen with regard to decreased water activity. Intoxication is caused by a toxin which is formed in the food. The toxin is relatively heat-stable and can survive boiling for more than an hour. It is therefore possible for well-cooked food to cause illness but not contain any viable *S. aureus* cells.
Incubation period	2–6 hours
Symptoms	An intoxication, sometimes of abrupt and violent onset. Severe nausea, cramps, vomiting and prostration, sometimes accompanied by diarrhoea.
Duration	About 2 days.
Reservoir/source	Humans (skin, nose, throat). *S. aureus* is carried by about 25–40% of the healthy population.
Mode of transmission and example of foods involved in outbreaks	Consumption of foods containing the toxin. Foods are contaminated by food handlers. If storage conditions are inadequate, the bacteria may multiply to produce toxin. Intoxication is often associated with cooked food, e.g. meat, where competitive bacteria have been destroyed. Examples of foods involved include prepared foods subject to handling in their preparation (ham, chicken and egg salads, cream-filled products, ice-cream, cheese).
Specific control measures	*Food service establishment/household*: Exclusion of food handlers with visibly infected skin lesions (boils, cuts etc.) from work; thorough personal hygiene of workers; prevention of time–temperature abuse in handling cooked/ready-to-eat foods.
Occurrence	Worldwide. The estimated rate of occurrence varies between ++ and +++ depending on conditions of food hygiene.
Other comments	Case-fatality rate is estimated at less than 0.02%.

Type of illness	**Typhoid and paratyphoid fevers**
ICD code	ICD-9: 002.0 and 002.1-002.9 ICD-10: A01.0 and A01.1-A01.4
Etiological agent	Bacteria: *Salmonella typhi* and *Salmonella paratyphi* types A-C.
Characteristics of the agent	As for non-typhoid salmonellae, except minimum growth pH is higher (4.9).
Incubation period	10-20 days with a range of 3 days to 8 weeks.
Symptoms	Systemic infections characterized by high fever, abdominal pains, headache, vomiting, diarrhoea followed by constipation, rashes and other symptoms of generalized infection.
Sequelae	Haemolytic anaemia.
Duration	Several weeks to months.
Reservoir/source	Humans.
Mode of transmission and example of foods involved in outbreaks	Ingestion of food and water contaminated with faecal matter. Food handlers carrying the pathogen may be an important source of food contamination. Secondary transmission may also occur. Examples of foods involved include prepared foods, dairy products (e.g. raw milk), meat products, shellfish, vegetables, salads.
Specific control measures	*Industrial:* treatment of drinking-water, and an effective sewage disposal system. *Food service establishment/household:* safe food preparation practices including careful hand-washing with soap and water, thorough cooking and reheating of food prior to consumption, disinfection of food preparation surfaces and thorough washing of all fruit and vegetables.
Occurrence	Predominantly in developing countries where the estimated rate of occurrence is ++. In industrialized countries the estimated rate of occurrence is +.
Other comments	Excretion of the organism may occur after recovery or by asymptomatic carriers, and this may be lifelong unless treated. Case-fatality rate is estimated at about 6% in industrialized countries.

Type of illness	***Vibrio parahaemolyticus* gastroenteritis**
ICD code	ICD-9: 005.4 ICD-10: A.05.3
Etiological agent	Bacterium: *Vibrio parahaemolyticus.*
Characteristics of the agent	Basic characteristics are the same as for *V. cholerae. V. parahaemolyticus* differs in that it is more halophilic and will grow at salt levels up to 8% and with a minimum a_w of 0.94. Growth is optimal and very fast at 37 °C (doubling time about 10 minutes) and will occur down to around 10 °C. *V. parahaemolyticus* is more sensitive to extremes of temperature than *V. cholerae* and will die at chill temperatures.
Incubation period	Often 9–25 hours, up to 3 days.
Symptoms	Profuse watery diarrhoea free from blood or mucus, abdominal pain, vomiting, and fever. A dysenteric syndrome has been reported from some countries, particularly Japan.
Sequelae	Septicaemia.
Duration	Up to 8 days.
Reservoir/source	Natural habitat is coastal seawater and estuarine brackish waters above 15 °C, and marine fish and shellfish.
Mode of transmission and example of foods involved in outbreaks	Mainly consumption of raw or undercooked fish and fishery products, or cooked foods subject to cross-contamination from raw fish.
Specific control measures	*Food service establishment/household:* thorough heat treatment of seafood; rapid chilling; prevention of cross-contamination from raw seafood products to other foods or preparation surfaces.
Occurrence	The illness has been reported primarily in countries in the WHO Western Pacific Region and in particular Japan as well as the WHO South-East Asia Region and the USA. Estimated rate of occurrence: +/++.
Other comments	Case-fatality rate in industrialized countries is less than 1%.

Type of illness	***Vibrio vulnificus* infection**
ICD code	ICD-9: 005.8 ICD-10: A05.8
Etiological agent	Bacterium: *Vibrio vulnificus*.
Characteristics of the agent	Gram-negative, non-spore-forming rods. Optimal temperature for growth is 37 °C.
Incubation period	12 hours–3 days.
Symptoms	Profuse diarrhoea with blood in stools; the organism is associated with wound infections and septicaemia which may originate from the gastrointestinal tract, or traumatized epithelial surfaces.
Sequelae	Produces septicaemia in persons with chronic liver diseases, chronic alcohol dependence, haemochromatosis, or those who are immunodepressed. Over 50% of patients with primary septicaemia may die; the fatality rate increases to 90% in hypotensive individuals.
Duration	Days–weeks.
Reservoir/source	Natural habitat is coastal or estuarine waters.
Mode of transmission and example of foods involved in outbreaks	All known cases are associated with seafood, particularly raw oysters.
Specific control measures	*Consumers*, particularly vulnerable groups including the elderly, those with underlying liver disease or immunodepressed through treatment or disease, and alcohol-dependent persons, should not eat raw seafood.
Occurrence	Frequently in Europe, USA and the WHO Western Pacific Region. Estimated rate of occurrence: +/++.
Other comments	Case-fatality rate can be as high as 40–60%.

Type of illness	**Yersiniosis**
ICD code	ICD-9: 027.8 ICD-10: A04.6
Etiological agent	Bacterium: *Yersinia enterocolitica.*
Characteristics of the agent	Gram-negative, facultatively anaerobic, motile, non-spore-forming rods of the family Enterobacteriaceae. *Y. enterocolitica* is a psychrotroph capable of growing at temperatures between 0 °C and 44 °C, but optimally at 29 °C. Growth will occur in a pH range of 4.6–9.0, but optimally at pH 7–8. It will grow in media containing 5% salt but not 7% salt.
Incubation period	1–11 days (but usually 24–36 hours).
Symptoms	Abdominal pain, diarrhoea accompanied by a mild fever, and sometimes vomiting.
Sequelae	Sequelae are observed in 2–3% of cases: reactive arthritis, Reiter disease, eye complaints and rash, cholangitis, erythema nodosum, septicaemia, hepatic and splenic abscesses, lymphadenitis, pneumonia, spondylitis.
Duration	Symptoms usually abate after 2–3 days; although they may continue in a milder form for 1–3 weeks.
Reservoir/source	A variety of animals, but pathogenic strains are most frequently isolated from pigs.
Mode of transmission and example of foods involved in outbreaks	Illness is transmitted through consumption of pork products (tongue, tonsils, gut), cured or uncured, as well as milk and milk products.
Specific control measures	*Food service establishment/household:* thorough cooking of pork products, and prevention of cross-contamination.
Occurrence	Northern Europe and Australia: estimated rate of occurrence: +/++; USA: estimated rate of occurrence: +.
Other comments	Untreated cases continue to excrete the organism for 2–3 months. The disease is often misdiagnosed as appendicitis. Case-fatality rate is 0.03%.

Type of illness	**Viral gastroenteriti**
ICD code	ICD-9: 008.8 ICD-10: A08
Etiological agent	Viruses: a number of different viruses have been established as causes of gastroenteritis. These include adenoviruses, coronaviruses, rotaviruses, parvoviruses, caliciviruses and astroviruses. Those most commonly associated with foodborne outbreaks are described as small, round, structured viruses (SRSV), which include Norwalk agent.
Characteristics of the agent	These viruses exhibit a range of biochemical and physical characteristics.
Incubation period	15-50 hours.
Symptoms	Diarrhoea, and vomiting which is often severe and projectile with sudden onset.
Duration	2 days.
Reservoir/source	Humans.
Mode of transmission and example of foods involved in outbreaks	Gastroenteritis viruses are usually spread by the faecal-oral route. Food and drinking-water may be contaminated either at source when exposed to sewage/wastewater in the environment or used for irrigation, or by an infected food handler. Filter-feeding shellfish are the most common food contaminated at source, but a far wider range of different cooked and uncooked foods have been implicated in secondary contamination by food handlers.
Specific control measures	Hygienic sewage disposal, treatment of drinking-water, treatment of wastewater used for irrigation. Good personal hygiene (i.e. hand hygiene); abstinence from handling food when ill, especially when diarrhoea is present.
Occurrence	Worldwide. Estimated rate of occurrence for rotavirus: ++/+++; and for other viral infections: +. Rotavirus infections constitute 15-25% of diarrhoeal disease cases identified in children and seen at treatment centres in the developing countries.

Type of illness	**Viral hepatitis A**
ICD code	ICD-9: 070.1 ICD-10: B15
Etiological agent	Virus: hepatitis A virus (member of Picornaviridae).
Characteristics of the agent	Small round virus, about 28 nm in diameter, containing single-stranded RNA. The virus multiplies in the gut epithelium before being carried by the blood to the liver. In the later part of incubation, the virus is shed in the faeces. Relatively acid-resistant.
Incubation period	2–6 weeks; usually about 25 days.
Symptoms	Early symptoms are loss of appetite, fever, malaise, abdominal discomfort, nausea and vomiting. These are followed by signs of liver damage such as passage of dark urine, pale stools and jaundice.
Sequelae	Liver disorders, particularly in older persons.
Duration	Varies in clinical severity: mild, with recovery within few weeks, to severe, lasting several months.
Reservoir/source	Humans: sewage and contaminated water.
Mode of transmission and example of foods involved in outbreaks	Spread through the faecal–oral route, primarily person-to-person. It can also be transmitted through food and water as a result of sewage contamination or infected food handlers. Risk of transmission is greatest during the second half of the incubation period until a few days after the appearance of jaundice. Examples of foods involved include: shellfish, raw fruit and vegetables, bakery products.
Specific control measures	*Industrial:* treatment of water supply, safe sewage disposal. *Food service establishment/household:* good personal hygiene, in particular, thorough hand-washing with soap and water before handling foods and abstinence from handling food when infected; thorough cooking of shellfish. An effective vaccine is available, and vaccination of professional food handlers and travellers should be considered.
Occurrence	Worldwide. Estimated rate of occurrence: ++.
Other comments	There may be asymptomatic carriers. Infection in adults is most severe. In children it is often asymptomatic and confers immunity. Case-fatality rate is low, about 0.3%. A higher case-fatality rate may occur in adults over 50 years of age.

Type of illness	**Poliomyelitis**
ICD code	ICD-9: 045 ICD-10: A80
Etiological agent	Virus: poliovirus; member of Picornaviridae.
Characteristics of the agent	Small round virus, which contains single-stranded RNA and can withstand acidity in the range of pH 3–5. The poliovirus infects the gastrointestinal tract and spreads to the regional nodes, and, in a minority of cases, to the nervous system.
Incubation period	3–14 days.
Symptoms	Poliomyelitis may be a transient viraemia characterized by fever and malaise. In a minority of cases, it may progress to a second stage of persistent viraemia where the virus invades the central nervous system causing varying degrees of paralysis and in some cases even death. Severe muscle pain and stiffness of the neck and back with or without flaccid paralysis are symptoms of the more severe illness. Flaccid paralysis occurs in less than 1% of poliovirus infections. Most often paralysis is in the legs, sometimes in the arms. Paralysis of the muscles used in respiration and/or swallowing is life-threatening. The infection in young children is usually asymptomatic and confers immunity, but is more severe in older children and young adults.
Sequelae	Permanent paralysis.
Reservoir/source	Humans; most frequently people with no apparent symptoms of infection.
Mode of transmission and example of foods involved in outbreaks	Principally person-to-person, through the faecal–oral route. Food and drinking-water are potential modes of transmission where hygiene standards are low. In some instances, milk and other foodstuffs contaminated with faeces have been a vehicle for transmission.
Specific control measures	Vaccination. Specific control measures with regard to food include: *Industrial:* treatment of drinking-water, and an effective sewage disposal system. *Food service establishment/household:* safe food preparation practices including careful hand-washing with soap and water, thorough cooking and reheating of food prior to consumption and thorough washing of all fruit and vegetables.
Occurrence	Poliomyelitis has been almost entirely eradicated in industrialized countries and the Americas as a result of effective immunization. In

	developing countries the estimated rate of occurrence varies from + to ++, depending on immunization programmes.
Other comments	During the few days prior to, and following the onset of symptoms, the risk of transmission is greatest. Infants and children under 5 years of age are the most frequently affected. Immunization of the elderly is recommended, particularly when travelling abroad.

Type of illness	**Amoebiasis (amoebic dysentery)**
ICD code	ICD-9: 006 ICD-10: A06
Etiological agent	Protozoa: *Entamoeba histolytica*.
Characteristics of the agent	An amoeboid protozoa that is an aerotolerant anaerobe. It survives in the environment in an encysted form. Cysts remain viable and infective for several days in faeces and may survive in soil for at least 8 days at 28–34 °C, and for more than 1 month at 10 °C. Relatively resistant to chlorine.
Incubation period	2–4 weeks, but may range from a few days to several months.
Symptoms	Severe bloody diarrhoea, stomach pains, fever and vomiting. Most infections remain symptomless.
Sequelae	Liver abscess.
Duration	Weeks–months.
Reservoir/source	Mainly humans, but also dogs and rats. The organism is also found in nightsoil, and sewage irrigation.
Mode of transmission and example of foods involved in outbreaks	Transmission occurs mainly through the ingestion of faecally contaminated food and water containing cysts. Cysts are excreted in large numbers (up to 5×10^7 cysts per day) by an infected individual. Illness is spread by the faecal–oral route, person-to-person contact or faecally contaminated food and water. Examples of foods involved include fruit and vegetables, and drinking-water.
Specific control measures	*Industrial:* filtration and disinfection of water supply; hygienic disposal of sewage water, treatment of irrigation water. *Food service establishment/household:* boiling of water, when safe water is not available; thorough washing of fruit and vegetables; thorough cooking of food; good hand hygiene.
Occurrence	Worldwide, particularly in young adults. Estimated rate of occurrence: very low in industrialized countries: +; very high in developing countries with poor sanitation: ++.

Type of illness	**Cryptosporidiosis**
ICD code	ICD-9: 136.8 ICD-10: A07.2
Etiological agent	Protozoa: *Cryptosporidium parvum.*
Characteristics of the agent	The organism has a complex life cycle that can take place in a single human or animal host. It produces resistant oocysts, typically 4–6 μm, which are very resistant to the chlorination process, but are killed by conventional cooking procedures.
Incubation period	2–14 days.
Symptoms	Diarrhoea (persistent diarrhoea), nausea, vomiting and abdominal pain sometimes accompanied by an influenza-like illness and fever.
Sequelae	Illness is more serious in the immunocompromised, particularly AIDS patients, and leads to severe nutrient malabsorption and weight loss.
Duration	A few days up to 3 weeks.
Reservoir/source	Humans and wild and domestic animals, e.g. cattle.
Mode of transmission and example of foods involved in outbreaks	Spread through the faecal–oral route, person-to-person contact, or consumption of faecally contaminated food and water. Other routes of transmission include swallowing water in contaminated swimming pools. Examples of foods involved include raw milk, drinking-water and apple cider.
Specific control measures	*Industrial:* pasteurization/sterilization of milk, filtration and disinfection of water, sanitary disposal of excreta, sewage and wastewater. *Food service establishment/household:* boiling of water when safe water is not available; boiling of milk; thorough cooking of food; good hand hygiene.
Occurrence	Worldwide. Cryptosporidiosis is one of the leading causes of diarrhoeal disease in infants and young children. It constitute 5–15% of diarrhoeal disease cases in children seen at treatment centres. The estimated occurrence is +++. In industrialized countries, it occurs often in day-care centres. Estimated occurrence: ++.
Other comments	Children under the age of 5 years are more at risk. Immunocompromised individuals, e.g. AIDS patients, may suffer from longer and more severe infection. In AIDS patients, infection may lead to death.

Type of illness	**Giardiasis**
ICD code	ICD-9: 007.1 ICD-10: A.07.1
Etiological agent	Protozoan: *Giardia lamblia.*
Characteristics of the agent	This flagellate protozoan has an environmentally resistant cyst stage as well as the vegetative trophozoite stage. Cysts are oval and 7–14 μm long. They are resistant to the chlorination process used in most water-treatment systems but are killed by conventional cooking procedures.
Incubation period	4–25 days, usually 7–10 days.
Symptoms	Once ingested the cysts release the active trophozoite which adheres to the gut wall. Illness is characterized by diarrhoea (which may be chronic and relapsing), abdominal cramps, fatigue, weight loss, anorexia and nausea. It is thought that the symptoms may be caused by a protein toxin.
Sequelae	Cholangitis, dystrophy, lymphoid hyperplasia.
Duration	Weeks–years.
Reservoir/source	Humans and animals.
Mode of transmission and example of foods involved in outbreaks	*Giardia* cysts are excreted in large numbers by an infected individual. Illness is spread through the faecal-oral route, person-to-person contact or faecally contaminated food and water. Cysts have been isolated from lettuces and fruit such as strawberries. The infection is also associated with drinking-water from surface waters and shallow wells. Examples of foods involved include: water, home-canned salmon and noodle salad.
Specific control measures	*Industrial:* filtration and disinfection of water supply; sanitary disposal of excreta and sewage; treatment of irrigation water. *Food service establishment/household:* boiling of water, when safe water is not available; thorough washing of fruit and vegetables; thorough cooking of foods; good hand hygiene. *Consumers*, such as campers, should avoid drinking surface water unless it has been boiled or filtered.
Occurrence	Worldwide. In industrialized countries, the estimated rate of occurrence is ++ and in developing countries with poor sanitation +++.
Other comments	Number of asymptomatic carriers is high. Children are affected more frequently than adults. Illness is prolonged and more serious in the immunocompromised, particularly AIDS patients. Tourists are particularly at risk.

Type of illness	**Toxoplasmosis and congenital toxoplasmosis**
ICD code	ICD-9: 130 and 771.2 ICD-10: B58 and P 37.1
Etiological agent	Protozoan: *Toxoplasma gondii* (belonging to the family Sarcocystidae).
Characteristics of the agent	A coccidian protozoan.
Incubation period	5–23 days.
Symptoms	Infections are often asymptomatic or present an acute disease with lymphadenopathy and lymphocytosis persisting for days or weeks.
Sequelae	During pregnancy transplacental infection may cause abortion or stillbirth, chorioretinitis, brain damage. In immunocompromised individuals infection may cause cerebritis, chorioretinitis, pneumonia, myocarditis, rash, or/and death. Cerebral toxoplasmosis is a particular threat for AIDS patients.
Reservoir/source	Cats and other felines; intermediate hosts are sheep, goats, rodents, pigs, cattle and birds, all of which may carry an infective stage of *T. gondii* encysted in tissue, e.g. muscle or brain, which remains viable for long periods, perhaps the entire life of the animal.
Mode of transmission and example of foods involved in outbreaks	Infections occur through ingestion of oocysts. Children may acquire the infection by playing in sand polluted with cat excreta. Oocysts shed by cats can sporulate and become infective 1–5 days later and may remain infective in water or soil for a year. Infection may also be acquired by eating raw or undercooked meat containing the cysts or food and water contaminated with feline faeces. Transplacental infection may also occur when the infection is acquired during pregnancy. Examples of foods involved include raw or undercooked meat, vegetables and goat's milk.
Specific control measures	*Industrial:* irradiation of meat. *Food service establishments, household:* thorough cooking of meat; careful washing of fruits and vegetables; good personal hygiene–particularly after contact with cats and before food preparation: safe disposal of cat faeces. *Consumers*, particularly pregnant women if not immune, should be advised to avoid raw or undercooked meat, wash vegetables carefully and wash hands after contact with cats.
Occurrence	Worldwide. Estimated rate of occurrence: + to ++.

Other comments	*T. gondii* cysts remain in the tissue and may reactivate if the immune system becomes compromised, e.g. by cytotoxic or immunosuppressive therapy or in patients with AIDS. In these groups the infection may be fulminant and fatal.

Type of illness	**Anisakiasis**
ICD code	ICD-9: 127.1 ICD-10: B81.0
Etiological agent	Helminth (nematode/roundworm): *Anisakis* spp. (larval stage).
Characteristics of the agent	Slender, threadlike parasite measuring 15–16 mm in length and 1 mm in diameter.
Incubation period	A few hours; symptoms related to the intestine a few days or weeks.
Symptoms	The motile larvae burrow into the stomach wall producing acute ulceration and nausea, vomiting and epigastric pain, sometimes with haematemesis. They migrate upward and attach themselves to the oropharynx causing coughing. In the small intestine they cause eosinophilic abscesses.
Reservoir/source	Sea mammals (for *Anisakis* spp. that are parasitic to humans).
Mode of transmission and example of foods involved in outbreaks	Consumption of the muscles of certain saltwater fish that have been inadequately processed. Examples of foods involved include sushi, sashimi, herring, cebiche.
Specific control measures	*Industrial:* irradiation; heat treatment, freezing, candling, cleaning (evisceration) of fish as soon as possible after they are caught (will prevent post-mortem migration of infective larvae from the mesenteries of the fish to muscles). *Food service establishment/household:* cleaning of fish; thorough cooking before consumption; freezing (–23 °C for 7 days).
Occurrence	Mainly in countries where consumption of raw or inadequately processed fish is common, e.g. Northern Europe, Japan, Latin America. Over 12 000 cases have been reported in Japan. Cases have also been reported in other parts of the world as eating habits change with migration.
Other comments	Symptoms mimic those of appendicitis.

Type of illness	Ascariasis
ICD code	ICD-9: 127.0 ICD-10: B77
Etiological agent	Helminth (nematode/roundworm): *Ascaris lumbricoides* (egg with infective larva).
Characteristics of the agent	*Ascaris lumbricoides* is a large roundworm infecting the small intestine. Adult males are 15–31 cm × 2–4 mm and females are 20–40 cm × 3–6 mm. Eggs undergo embryonation in the soil; after 2–3 weeks at warm temperature they become infective and may remain viable for several months or even years in favourable soils. The larvae emerge from the egg in the duodenum, penetrate the intestinal wall and reach the heart and the lungs in the blood. Larvae grow and develop in the lungs; 9–10 days after infection they break out of the pulmonary capillaries into the alveoli and migrate through the bronchial tubes and trachea into the pharynx where they are swallowed and reach the intestine 14–20 days after infection. In the intestine they develop into adults and begin laying eggs 40–60 days after ingestion of the embryonated eggs. The life cycle is complete after 8 weeks.
Incubation period	First appearance of eggs in stools is 60–70 days. In larval ascariasis, symptoms occur 4–16 days after infection.
Symptoms	Gastrointestinal discomfort, colic and vomiting, fever; observation of live worms in stools. Some patients may have pulmonary symptoms or neurological disorders during migration of the larvae. However, there are generally few or no symptoms.
Sequelae	A heavy worm infestation may cause nutritional deficiency; other complications, sometimes fatal, include obstruction of the bowel by a bolus of worms (observed particularly in children), obstruction of bile or pancreatic duct.
Reservoir/source	Humans; soil and vegetation on which faecal matter containing eggs has been deposited.
Mode of transmission and example of foods involved in outbreaks	Ingestion of infective eggs from soil contaminated with human faeces or from contaminated vegetables and water.
Specific control measures	Use of toilet facilities; safe excreta disposal; protection of food from dirt and soil; thorough washing of produce. Food dropped on the floor should not be eaten without washing or cooking, particularly in endemic areas.
Occurrence	Worldwide. There is a high prevalence (exceeding 50%) in moist and tropical countries. Estimated rate of occurrence: + to +++ depending on the region.
Other comments	In endemic areas the highest prevalence is among children aged 3–8 years.

Type of illness	**Trichinellosis (trichiniasis, trichinosis)**
ICD code	ICD-9: 124 ICD-10: B75
Etiological agent	Helminth (nematode/roundworm): *Trichinella spiralis* (larvae in infected muscle).
Characteristics of the agent	White intestinal worm, visible to the naked eye. The transmissible form of this parasite is a larval cyst approximately 0.4 mm × 0.25 mm which occurs in pork muscle. In the initial phase of trichinellosis, the larvae ingested with the meat develop rapidly into adults in the epithelium of the intestine. Female worms produce larvae which penetrate the lymphatics or venules and are disseminated via the blood throughout the body. The larvae become encapsulated in the skeletal muscle.
Incubation period	Initial phase: a few days. Systemic symptoms: 8–21 days.
Symptoms	Symptoms range from inapparent infection to fulminating and fatal disease, depending on the number of larvae ingested. Symptoms during the initial invasion are nausea, vomiting, diarrhoea and fever. During the phase of parasite dissemination to the tissues, there may be rheumatic manifestations, muscle soreness and pain together with oedema of the upper eyelids, sometimes followed by subconjunctival, subungual and retinal haemorrhages, pain and photophobia. Thirst, profuse sweating, chills, weakness, prostration and rapidly increasing eosinophilia may follow shortly after the ocular symptoms.
Sequelae	Cardiac and neurological complications may appear in weeks 3–6; in the most severe cases death due to myocardial failure may occur.
Duration	2 weeks to 2–3 months.
Reservoir/source	Pigs, dogs, cats, rats, horses and other mammals in the domestic environment.
Mode of transmission and example of foods involved in outbreaks	Ingestion of raw or undercooked meat containing the encysted larvae. Examples of foods involved include pork, horse, game (wild boar, bear).
Specific control measures	*Industrial:* irradiation of meat, freezing, heating and curing. *Food service establishment/household:* thorough cooking of meat, freezing (e.g. minus 15 °C for 30 days). *Consumers:* hunters should thoroughly cook all game.
Occurrence	Worldwide, with predominance in countries where pork or game is eaten.

Type of illness	**Taeniasis:** *Taenia solium* taeniasis and cysticercosis *Taenia saginata* taeniasis
ICD code	ICD-9: 123.0 (*Taenia solium* taeniasis); 123.2 (*Taenia saginata* taeniasis); 123.1 (cysticercosis) ICD-10: B68.0 (*Taenia solium* taeniasis); B68.1 (*Taenia saginata* taeniasis); B69 (cysticercosis)
Etiological agent	Helminth (cestode/tapeworm): *Taenia solium* and *Cysticercus cellulosae*[a] (larvae of *T. solium*) *Taenia saginata* and *Cysticercus bovis*[b] (larvae of *T. saginata*).
Characteristics of the agent	*T. solium* causes both intestinal infection with adult worms as well as somatic infection with the eggs. The adult worm comprises a scolex 1 mm in diameter, armed with two rows of hooks and four suckers. The strobila ranges in length from 1.8 m to 4 m. *T. saginata* causes only intestinal infection with adult worms. The adult worm comprises a scolex 1–2 mm in diameter, equipped with four suckers, a neck, and a strobila that ranges in length from 35 mm to 6 m.
Incubation period	Symptoms of cysticercosis appear from a few days to over 10 years. Eggs appear in the stools 8–12 weeks after infection with *T. solium*, and 10–14 weeks after infection with *T. saginata*.
Symptoms	Nervousness, insomnia, anorexia, weight loss, abdominal pain and digestive disturbance. Cysticercosis may cause epileptiform seizures, signs of intracranial hypertension or psychiatric disturbance. Cysticercosis may be fatal.
Sequelae	Cysticercosis may affect the central nervous system. When eggs or proglottides of *T. solium* are swallowed, the eggs hatch in the small intestine and the larvae migrate to subcutaneous tissue, striated muscles, and other tissues and vital organs of the body where they form cysts. Severe health consequences occur when the larvae localize in the eye, central nervous system or heart.
Reservoir/source	Humans; pigs and cattle are the intermediate host for *T. solium* and *T. saginata*.
Mode of transmission and example of foods involved in outbreaks	Taeniasis is caused by consumption of raw or undercooked beef (*Taenia saginata*) or pork (*Taenia solium*) containing cysticerci. Gravid proglottides of the parasite are excreted in faeces. Eggs within the

[a,b] Names assigned before the organisms were found to be the larval forms of *T. solium* and *T. saginata*, respectively.

	segments are infective. Cattle ingest the eggs deposited on pasture and pigs ingest those deposited on soil. When viable eggs are ingested by cattle or pigs they develop into cysticerci in the muscle. Cysticercosis is caused by ingestion of *T. solium* eggs by the faecal-oral route, person-to-person contact, autoinfection (unwashed hands) or consumption of contaminated food, e.g. vegetables.
Specific control measures	*Industrial:* prevention of faecal contamination of soil, water, human and animal food through safe disposal of sewage; avoidance of sewage water for irrigation use. Irradiation, heat treatment, and freezing kill the cysticerci. *Food service establishment/household:* thorough cooking of meat. *Other:* early diagnosis and treatment to prevent cysticercosis.
Occurrence	Worldwide. Most common in Africa, Latin America, eastern Europe, and south-east Asia. Estimated rate of occurrence varies from + to ++ in high prevalence areas.
Other comments	*T. saginata* eggs are infective only in cattle, *T. solium* eggs are infective in pigs and humans. Eggs of both species are disseminated in the environment as long as the worm remains in the intestine, sometimes for more than 30 years; eggs may remain viable in the environment for months.

Type of illness	**Clonorchiasis**
ICD code	ICD-9: 121.1 ICD-10: B66.1
Etiological agent	Helminth (trematode/flatworm): *Clonorchis sinensis*, also known as Chinese or oriental liver fluke.
Characteristics of the agent	This is a flattened worm, 10–25 mm long, 3–5 mm wide and usually spatula shaped. It is yellow-brown, owing to bile staining, has an oral and a ventral sucker and is a hermaphrodite. Eggs measure 20–30 μm × 15–17 μm; they are operculate and among the smallest trematode eggs to occur in humans.
Incubation period	Unpredictable: varies with the number of worms present. Symptoms begin with the entry of immature flukes into the biliary system, within one month after encysted larvae (metacercariae) are ingested.
Symptoms	Gradual onset of discomfort in the right upper abdominal quadrant, anorexia, indigestion, abdominal pain or distension and irregular bowel movement. Patients who are heavily infected experience weakness, weight loss, epigastric discomfort, abdominal fullness, diarrhoea, anaemia, oedema. In the later stages, jaundice, portal hypertension, ascites and upper gastointestinal bleeding occur.
Sequelae	The liver (predominantly the left lobe) is enlarged. The spleen can be palpated in only a small percentage of infected cases. Recurrent pyogenic cholangitis is a serious complication of clonorchiasis. The pancreas may be involved in severe cases of *C. sinensis* infection. The pathology of pancreatic clonorchiasis is similar to that of hepatic lesion, namely adenomatous hyperplasia of the ductal epithelium. When acute pancreatitis occurs, features of inflammation are present. Cholangiocarcinoma is also associated with clonorchiasis. Repeated or heavy infection during childhood has been reported to cause dwarfism with retarded sexual development.
Reservoir/source	Snails are the first intermediate host. Some 40 species of river fish serve as the second intermediate host. Humans, dogs, cats and many other species of fish-eating mammals are definitive hosts.
Mode of transmission and example of foods involved in outbreaks	People are infected by eating raw or under-processed freshwater fish containing encysted larvae (metacercariae). During digestion, the larvae are freed from the cysts and migrate via the common bile duct to biliary radicles. Eggs deposited in the bile passages are evacuated in faeces. Eggs in faeces contain fully developed miracidia; when ingested by a susceptible operculate snail, they hatch in its intestine, penetrate the tissues and asexually generate larvae (cercariae) that migrate into the water. On

	contact with a second intermediate host, the cercariae penetrate the host and encyst, usually in muscle, occasionally on the underside of scales. The complete life cycle from person to snail to fish to person requires at least 3 months.
Specific control measures	*Industrial*: Safe disposal of excreta and sewage/wastewater to prevent contamination of rivers; treatment of wastewater used for aquaculture; irradiation of freshwater fish; freezing; heat treatment, e.g. canning. *Food service establishment/household*: thorough cooking of freshwater fish. *Consumers* should avoid consumption of raw or undercooked freshwater fish. *Other*: control of snails with molluscicides where feasible; drug treatment of the population to reduce the reservoir of infection; elimination of stray dogs and cats.
Occurrence	Endemic in western Pacific areas: China, Hong Kong SAR, Japan, Malaysia, Republic of Korea, Singapore, Viet Nam. Estimated rate of occurrence: ++/+++. In Europe: east of Russian Federation (estimated rate of occurrence: ++).
Other comments	About one-third of chronic infections are asymptomatic.

Type of illness	**Fascioliasis**
ICD code	ICD-9: 121.3 ICD-10: B66.3
Etiological agent	Helminth (trematode/flatworm/liver fluke): *Fasciola hepatica* and *Fasciola gigantica*.
Characteristics of the agent	*Fasciola hepatica*: large fluke (23–30 mm × 15 mm), pale grey in colour with dark borders, leaf-shaped with a distinct cephalic cone at the anterior end. Eggs are usually 130–150 μm × 63–90 μm. They have an inconspicuous operculum, are non-embryonated, and often have a shell irregularity at the abopercular end. *Fasciola gigantica* is bigger and may reach a length of 75 mm.
Incubation period	4–6 weeks.
Symptoms	Fever, sweating, abdominal pain, dizziness, cough, bronchial asthma, urticaria. In children, the acute infection is accompanied by severe clinical manifestations, including right upper quadrant pain or generalized abdominal pain, fever and anaemia, and can be fatal. Ectopic infections are common in humans.
Sequelae	Necrotic lesions, inflammatory, adenomatous and fibrotic changes in the bile duct, biliary stasis, atrophy of the liver and periportal cirrhosis, cholecystitis and cholelithiasis.
Reservoir/source	Snails are the intermediate host; sheep, cattle and humans are the definitive hosts.
Mode of transmission and example of foods involved in outbreaks	Infection in humans is associated with the consumption of uncultivated raw watercress (*Nasturtium officinale*) and other salad plants, such as dandelions, bearing metacercariae. After ingestion, the larvae are released from the cyst envelopes into the duodenum, pass through the intestinal wall to the abdominal cavity, enter the liver and after development enter the bile ducts and begin laying non-embryonated eggs 3–4 months after initial exposure. The eggs are carried by the bile into the intestine, and evacuated with the faeces. In suitable temperature and humidity conditions the eggs mature and the miracidia emerge from the eggs into the water in a few weeks. The miracidia penetrate the snail (intermediate host), turn into sporocysts and in about 3 weeks produce rediae which, in turn, produce cercariae. The cercariae may begin to emerge from the snails in 6 weeks under favourable conditions. After leaving the snail, the cercariae swim in the water and encyst on vegetation, turning into metacercariae which can survive for a long time in a wet environment. The life cycle is then complete.

Specific control measures	*Industrial*: Safe disposal of excreta and sewage/wastewater; drug treatment of livestock against the parasite; prevention of animal access to commercial watercress beds and control of water used to irrigate the beds. *Food service establishment/household*: thorough cooking of food. *Consumers* should avoid consumption of raw watercress. *Other*: control of snails with molluscicides where feasible; drug treatment of the population to reduce the reservoir of infection.
Occurrence	Africa, e.g. Egypt, Ethiopia; Americas, e.g. Bolivia, Ecuador, Peru; Asia, e.g. Islamic Republic of Iran; Europe: France, Portugal, Spain; and the western Pacific, e.g. China. The estimated rate of occurrence varies, depending on the country, from ++ to +++.

Type of illness	**Opisthorchiasis**
ICD code	ICD-9: 121.0 ICD-10: B66.0
Etiological agent	Helminth (trematode/flatworm/liver fluke): *Opisthorchis viverrini* and *Opisthorchis felineus*.
Characteristics of the agent	Morphological features ressemble those of *Clonorchis sinensis*. The worm lives in the intrahepatic bile ducts and pancreas and has been also found in the lungs. It measures 8–11 mm × 1.5–2 mm. Eggs measure 30 µm × 12 µm and are slenderer than the *C. sinensis* eggs.
Incubation period	2–4 weeks, very occasionally 1 week.
Symptoms	Fever, abdominal pain, dizziness, urticaria. Chronic cases may lead to diarrhoea, flatulence, fatty food intolerance, epigastric and right upper quadrant pain, jaundice, fever, hepatomegaly, lassitude, anorexia, and in some cases emaciation and oedema.
Sequelae	Cholecystitis, cholangitis, liver abscess and gallstones. Cholangiocarcinoma is associated with *O. viverrini* infection and perhaps also with *O. felineus*.
Reservoir/source	The first intermediate host is the freshwater snail; several fish species act as second intermediate host. Humans, dogs, cats, and other mammals that eat fish or fish waste are definitive hosts.
Mode of transmission and example of foods involved in outbreaks	Humans are infected by consumption of raw or under-processed freshwater fish. The life cycle of *Opisthorchis* spp. is similar to that of *C. sinesis*.
Specific control measures	*Industrial*: Safe disposal of excreta and sewage/wastewater; treatment of wastewater used for aquaculture; irradiation of freshwater fish; freezing; heat treatment, e.g. canning. *Food service establishment/household*: thorough cooking of freshwater fish. Consumers should avoid consumption of raw or undercooked freshwater fish. *Other*: control of snails with molluscicides where feasible; drug treatment of the population to reduce the reservoir of infection; elimination of stray dogs and cats.
Occurrence	*Opisthorchis viverrini*: Cambodia, Lao People's Democratic Republic, Thailand.

Opisthorchis felineus: Europe: Baltic states, eastern Germany, Kazakhstan, Poland, the Russian Federation, Ukraine; Asia: India, Japan, Thailand. The estimated rate of occurrence is ++ in European countries and +++ in Asian countries.

Type of illness	**Paragonimiasis**
ICD code	ICD-9: 121.2 ICD-10: B66.4
Etiological agent	Helminth (trematode/flatworm/lung fluke): *Paragonimus westermani* (metacercariae).
Characteristics of the agent	This is a reddish brown hermaphrodite which measures 10–12 mm in length and 5–7 mm in width (adult). The shape varies from linear to spherical. Eggs usually measure 80–120 µm, are golden brown in colour, thick-shelled, non-embryonated in faeces or in sputum and have a prominent operculum. The shell is thickened at the abopercular end.
Incubation period	Acute stage: a few days to several weeks. Chronic stage: pulmonary symptoms begin at around 3 months.
Symptoms	The early stages are usually asymptomatic. However, heavily infected patients may experience fever, fatigue, generalized myalgia and abdominal pain with eosinophilia.
Sequelae	Pleuropulmonary paragonimiasis (pulmonary lesion): chronic coughing, thoracic pain, blood-stained viscous sputum. Systemic symptoms of fatigue, fever, myalgia, chest pain and dyspnoea. Severe infections produce tuberculosis-like symptoms. Ectopic paragonimiasis (extrapulmonary lesion): migration of the worm through the brain can cause cerebral haemorrhage, oedema or meningitis. Severe headache, mental confusion, seizure, hemiparesis, hypaesthesia, blurred vision, diplopia, homonymous hemianopsia and meningismus may occur. Abdominal paragonimiasis: results in abdominal pain, and there may be diarrhoea with blood and mucus when the intestinal mucosa is ulcerated.
Reservoir/source	Freshwater snails are the first intermediate host; crabs and crayfish are second intermediate hosts. Humans, dogs, pigs and other wild and domestic animals are definitive hosts.
Mode of transmission and example of foods involved in outbreaks	The definitive hosts are infected through consumption of raw, inadequately cooked or otherwise under-processed freshwater crustaceans (crabs and crayfish) which contain the metacercariae, or through contamination of other food items, hands and cooking utensils by the metacercariae released from infected crabs during food preparation. Following ingestion the metacercariae in the infected crustaceans excyst in the duodenum of the host and the larvae penetrate the intestinal wall and migrate beneath the peritoneum where they remain for 5–7 days. Over a period of about 2–3 weeks following infection, the immature worms penetrate the

	diaphragm, enter the pleural cavity and then move into the lung parenchyma where they mature. At this stage, eggs may be present in the sputum without the host showing any symptoms. During the initial stage of lung infection, the adult worms migrate through the tissues and cause focal haemorrhagic pneumonia. After 12 weeks, the worms in the lung parenchyma typically provoke a granulomatous reaction that gradually proceeds to development of fibrotic encapsulation. Extrapulmonary lesions are caused by worms that reach and develop in ectopic foci.
Specific control measures	*Industrial*: safe disposal of excreta and sewage/wastewater to prevent contamination of rivers. *Food service establishment/household*: thorough cooking of crabs and crayfish, and hygienic handling of these foods. *Consumers* should avoid consumption of raw or undercooked or under-processed crabs and crayfish. *Other*: control of snails with molluscicides where feasible; drug treatment of the population to reduce the reservoir of infection; elimination of stray dogs and cats.
Occurrence	Africa, e.g. Cameroon, Nigeria; Americas, e.g. Ecuador, Peru; Asia, e.g. China, Japan, Lao People's Democratic Republic, Philippines, Republic of Korea, Thailand. Estimated rate of occurrence in these countries is +++.

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ANNEX 2

Risk communication[1]

Definition and goals

Risk communication is the exchange of information and opinions concerning risk and risk-related factors among risk assessors, risk managers, consumers and other interested parties. The fundamental goal of risk communication is to provide meaningful, relevant and accurate information, in clear and understandable terms targeted to a specific audience.

The goals of risk communication are:

— to promote awareness and understanding of the specific issues under consideration during the risk analysis process, by all participants;
— to promote consistency and transparency in arriving at and implementing risk management[2] decisions;
— to provide a sound basis for understanding the risk management decisions proposed or implemented;
— to improve the overall effectiveness and efficiency of the risk analysis process;
— to contribute to the development and delivery of effective information and education programmes, when they are selected as risk management options;
— to foster public trust and confidence in the safety of the food supply;
— to strengthen working relationships and mutual respect among all participants;
— to promote the appropriate involvement of all interested parties in the risk communication process;
— to exchange information on the knowledge, attitudes, values, practices and perceptions of interested parties concerning risks associated with food and related topics.

[1] Excerpted from: *The application of risk communication to food standards and safety matters. The Report of a Joint FAO/WHO Expert Consultation, Rome, 2-6 February 1998.* Rome, Food and Agriculture Organization of the United Nations, 1999 (FAO Food and Nutrition Paper, No. 70).

[2] Risk management is the process of weighing policy alternatives in the light of the results of risk assessment and, if required, selecting and implementing appropriate control options, including regulatory measures.

Elements of risk communication

Depending on what is to be communicated and to whom, risk communication messages may contain information on the following:

The nature of the risk

- The characteristics and importance of the hazard of concern.
- The magnitude and severity of the risk.
- The urgency of the situation.
- Whether the risk is becoming greater or smaller (trends).
- The probability of exposure to the hazard.
- The distribution of exposure.
- The amount of exposure that constitutes a significant risk.
- The nature and size of the population at risk.
- Who is at the greatest risk.

The nature of the benefits

- The actual or expected benefits associated with each risk.
- Who benefits and in what ways.
- Where the balance point is between risks and benefits.
- The magnitude and importance of the benefits.
- The total benefit to all affected populations combined.
- Uncertainties in risk assessment.
- The methods used to assess the risk.
- The importance of each of the uncertainties.
- The weaknesses of, or inaccuracies in, the available data.
- The assumptions on which estimates are based.
- The sensitivity of the estimates to changes in assumptions.
- The effect of changes in the estimates on risk management decisions.

Risk management options

- The action(s) taken to control or manage the risk.
- The action individuals may take to reduce personal risk.
- The justification for choosing a specific risk management option.
- The effectiveness of a specific option.
- The benefits of a specific option.
- The cost of managing the risk, and who pays for it.
- The risks that remain after a risk management option is implemented.

Principles of risk communication

Know the audience

In formulating risk communication messages, the audience should be analysed in order to understand their motivations and opinions. Beyond knowing in general who the audience is, it is necessary to get to know them as groups and ideally as individuals to understand their concerns and feelings and to maintain an open channel of communication with them. Listening to all interested parties is an important part of risk communication.

Involve the scientific experts

Scientific experts, in their capacity as risk assessors, must be able to explain the concepts and processes of risk assessment. They need to be able to explain the results of their assessment and the scientific data, assumptions and subjective judgements upon which it is based, so that risk managers and other interested parties clearly understand the risk. They must be able to communicate clearly what they know and what they do not know, and to explain the uncertainties related to the risk assessment process. In turn, risk managers must be able to explain how risk management decisions are arrived at.

Establish expertise in communication

Successful risk communication requires expertise in conveying understandable and usable information to all interested parties. Risk managers and technical experts may not have the time or skill to perform complex risk communication tasks, such as responding to the needs of various audiences (public, industry, media etc.) and preparing effective messages. People with expertise in risk communication should therefore be involved as early as possible. This expertise will probably have to be developed by training and experience.

Be a credible source of information

Information from credible sources is more likely to influence the public perception of a risk than is information from sources that lack this attribute. The credibility accorded a source by a target audience may vary according to the nature of the hazard, culture, social and economic status, and other factors. If consistent messages are received from multiple sources, the credibility of the message is reinforced. Factors determining credibility of the source include recognized competence or expertise, trustworthiness, fairness, and lack of bias. For example, the terms that consumers have associated with high credibility include "factual", "knowledgeable", "expert", "public welfare", "responsible", "truthful", and "good track record". Trust and credibility

must be nurtured and can be eroded or lost through ineffective or inappropriate communication. In studies, consumers have indicated that distrust and low credibility result from exaggeration, distortion and perceived vested interest.

Effective communications acknowledge current issues and problems, are open in their content and approach, and are timely. Timeliness of the message is most important since many controversies become focused on the question "why didn't you tell us sooner?" rather than on the risk itself. Omissions, distortions and self-serving statements will damage credibility in the longer term.

Share responsibility

Regulatory agencies of governments at national, regional and local levels have a fundamental responsibility for risk communication. The public expects the government to play a leading role in managing public health risks. This is true when the risk management decision involves regulatory or voluntary controls, and is even true when the government decision is to take no action. In the latter event, communication is still essential to provide reasons why taking no action is the best option. In order to understand the public concerns and to ensure that risk management decisions respond to those concerns in appropriate ways, the government needs to determine what the public knows about the risks and what the public thinks of the various options being considered to manage those risks.

The media play an essential role in the communication process and therefore share in these responsibilities. Communication on immediate risks involving human health, particularly when there is a potential for serious health consequences such as in the case of foodborne illnesses, cannot be treated in the same way as less immediate food safety concerns. Industry also has a responsibility for risk communication, especially when the risk is a result of its products or processes. All parties in the risk communication process (e.g. government, industry, media) have joint responsibility for the outcome even though their individual roles may differ. Since science must be the basis for decision-making, all parties in the communication process should know the basic principles and data supporting the risk assessment and the policies underlying the risk management decisions.

Differentiate between science and value judgement

It is essential to separate facts from values in considering risk management options. At a practical level, it is useful to report the facts that are known at the time as well as what uncertainties are involved in the risk management decisions being proposed or implemented. The risk communicator has the respon-

sibility to explain what is known as fact and where the limits of this knowledge begin and end. Value judgements are involved in the concept of acceptable levels of risk. Consequently, risk communicators should be able to justify the level of acceptable risk to the public. Many people take the term "safe food" to mean food with zero risk, but zero risk is often unattainable. In practice, "safe food" usually means food that is safe enough. Making this clear is an important function of risk communication.

Assure transparency

If the public are to accept the risk analysis process and its outcomes, the process must be transparent. While respecting legitimate concerns to preserve confidentiality (e.g. proprietary information or data), transparency in risk analysis consists of having the process open and available for scrutiny by interested parties. Effective two-way communication between risk managers, the public and interested parties is both an essential part of risk management and a key to achieving transparency.

Put the risk in perspective

One way to put a risk in perspective is to examine it in the context of the benefits associated with the technology or process that poses the risk. Another approach that may be helpful is to compare the risk at issue with other similar, more familiar risks. However, this latter approach can create problems if it appears that risk comparisons have been intentionally chosen to make the risk at issue seem more acceptable to the public. In general, risk comparisons should not be used unless:

- — both (or all) risk estimates are equally sound;
- — both (or all) risk estimates are relevant to the specific audience;
- — the degree of uncertainty in all risk estimates is similar;
- — the concerns of the audience are acknowledged and addressed;
- — the substances, products or activities themselves are directly comparable, including the concept of voluntary and involuntary exposure.

General requirements for effective risk communication

Many considerations for effective risk communication, especially those involving the public, can be grouped in a sequence following the systematic approach of the risk communication process. This starts with gathering background and needed information, followed by the preparation and assembly of the message, its dissemination and distribution, and a follow-up review and evaluation of its impact.

Background and information

- Understand the scientific basis of the risks and attendant uncertainties.
- Understand the public perception of the risk through such means as risk surveys, interviews and focus groups.
- Find out what risk information people want.
- Be sensitive to related issues that may be more important to people than the risk itself.
- Expect different people to see the risk differently.

Preparation and assembly

- Avoid comparisons between familiar risks and new risks, as they may seem flippant and insincere unless presented properly.
- Recognize and respond to the emotional aspects of risk perceptions. Speak with sympathy and never use logic alone to convince an audience characterized by emotion.
- Express risk in several different ways, making sure not to evade the risk question.
- Explain the uncertainty factors which are used in risk assessment and standard setting.
- Maintain an openness, flexibility, and recognition of public responsibilities in all communication activities.
- Build an awareness of benefits associated with a risk.

Dissemination/distribution

- Accept and involve the public as a legitimate partner by describing risk/benefit information and control measures in an understandable way.
- Share the public's concern rather than deny it as not legitimate or as unimportant. Be prepared to give people's concerns as much emphasis as the risk statistics.
- Be honest, frank, and open in discussing all issues.
- If explaining statistics derived from risk assessment, explain the risk assessment process before presenting the numbers.
- Coordinate and collaborate with other credible sources.
- Meet the needs of the media.

Review/evaluation

- Evaluate the effectiveness of risk messages and communication channels.
- Emphasize action to monitor, manage, and reduce risk.
- Plan carefully and evaluate efforts.

Points to consider regarding public concerns

Risks that involve some or all of the following aspects tend to concern the public more than those risks that lack these aspects:

— unknown, unfamiliar or rare events as opposed to well-known or common hazards;
— risks controlled by others, rather than those where the public or the individual is in control;
— risks that result from the action of industry or new technology, rather than those perceived as natural;
— risks where there is significant scientific uncertainty, or where there is open controversy among experts as to the probability and severity of the hazard;
— risks that raise moral or ethical questions, such as the fairness of the distribution of risks and benefits, or the rights of one group in society to put others at risk;
— the decision-making process by which the risk is assessed is seen as being unresponsive or is unknown.

Therefore, in order to mitigate public concern about risks, the following strategies may be used:

- Make risks voluntary by giving consumers choices, whenever possible.
- Acknowledge uncertainty.
- Show that expert disagreement on an issue is merely uncertainty, by estimating risks as a range that includes estimates from both sides of the debate.
- Determine where control is and look to share it with interested parties.
- Treat all interested parties with courtesy.
- Always consider concerns and complaints seriously.