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Appendix 1

This Appendix supports Chapter 7, 'Linking risk assessment and economic analysis'. Figure A1 is a generic disease outcome tree that can be used by the risk assessment team to display the diverse human health outcomes that occur after exposure to a foodborne pathogen. Table A1 lists foodborne pathogens and their possible complications that cover a diversity of outcomes, including paralysis, kidney failure, mental retardation, septicaemia or blood poisoning, and arthritis. Many foodborne pathogens are listed, suggesting that many foodborne illnesses have some probability of complications.

Table A2 lists the varied economic costs that can be included in a cost–benefit analysis. Exactly which costs are included depends on the type of cost–benefit analysis. It is important to be clear about the nature of the policy intervention, and to clearly understand which costs belong in the benefit vs. cost categories. For example, in installing an improved food safety programme and reducing the level of pathogen contamination in food, a company could see offsetting benefits in terms of increased product shelf-life, a decrease in product returns, reduced insurance premiums, fewer product liability cases, a reduced risk of product recalls due to foodborne illness, and even an increase in sales over time. These benefits to the company could offset the costs of its new food safety programme. Economic analysis is interested in identifying and comparing the present value of the net benefits and net costs for all parties affected by the public or private policy intervention.

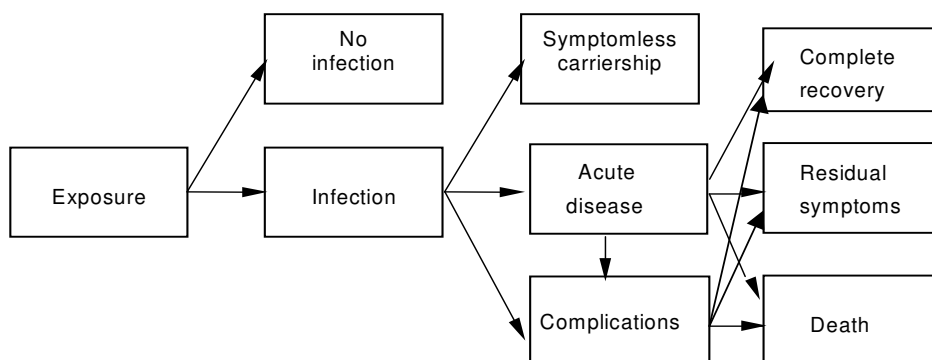


Figure A1. Generic disease outcome tree (adapted from Prüss and Havelaar, 2001).

Table A1 Chronic complications associated with foodborne pathogens.

Bacterial and parasitic infections transmitted by food	Complications/sequelae
Bacterial infections	
<i>Aeromonas hydrophila</i> enteritis	Bronchopneumonia, cholecystitis
Bruceellosis	Aortitis, epididymo-orchitis, meningitis, pericarditis, spondylitis
Campylobacteriosis	Arthritis, carditis, cholecystitis, colitis, endocarditis, erythema nodosum, Guillain-Barré syndrome, haemolytic-uraemic syndrome, meningitis, pancreatitis, septicaemia
<i>Escherichia coli</i> (EHEC-types) enteritis	Erythema nodosum, haemolytic-uraemic syndrome, seronegative arthropathy, thrombocytopenic purpura
Q-fever	Endocarditis, granulomatous hepatitis
Salmonellosis	Aortitis, cholecystitis, colitis, endocarditis, epididymo-orchitis, meningitis, myocarditis, osteomyelitis, pancreatitis, Reiter's disease, rheumatoid syndromes, septicaemia, splenic abscesses, thyroiditis, septic arthritis (sickle-cell anaemic persons)
Shigellosis	Erythema nodosum, haemolytic-uraemic syndrome, peripheral neuropathy, pneumonia, Reiter's disease, septicaemia, splenic abscesses, synovitis
<i>Vibrio parahaemolyticus</i> enteritis	Septicaemia
Yersiniosis	Arthritis, cholangitis, erythema nodosum, liver and splenic abscesses, lymphadenitis, pneumonia, pyomyositis, Reiter's disease, septicaemia, spondylitis, Still's disease
Parasitic infections	
Cryptosporidiosis ^a	Severe diarrhoea, prolonged and sometimes fatal
Giardiasis ^a	Cholangitis, dystrophy, joint symptoms, lymphoidal hyperplasia
Taeniasis	Arthritis, cysticercosis (<i>T. solium</i>)
Toxoplasmosis	Encephalitis and other central nervous system diseases, pancarditis, polymyositis
Trichinosis	Cardiac dysfunction, neurological sequelae

NOTES: (a) Waterborne.

SOURCE: Foege and Roberts, 1994.

Table A2 Examples of societal costs of foodborne illness involving a zoonotic disease.

Costs to Individuals and Households¹			
Human Illness Costs	Medical costs	Physician visits Laboratory costs Hospitalization or nursing home Drugs and other medications Ambulance or other travel costs	
		Income or productivity loss for ill person or death	
		Caregiver for ill person	
	Other illness costs	Travel costs to visit ill person Home modifications Vocational or physical rehabilitation Child care costs Special educational programmes Institutional care Lost leisure time	
	Psychological costs	Pain and other psychological costs Risk aversion	
	Averting behaviour costs	Extra cleaning or cooking time costs	
		Extra cost of refrigerator, freezer, etc.	
		Flavour changes from traditional recipes (especially meat, milk, egg dishes)	
		Increased food cost if more expensive but safer foods are purchased	
	Industry Costs²		
Impact of pathogens on animal production costs	Morbidity and mortality of animals on farms		
	Reduced growth rate or feed efficiency and increased time to market		
	Costs of disposal of contaminated animals on farm and at slaughterhouse		
	Increased trimming or re-working at slaughterhouse and processing plant		
	Illness among workers because of handling contaminated animals or products		
	Increased meat product spoilage due to pathogen contamination		
Control costs for pathogens at all links in the food chain ² :	New farm practices (age-segregated housing, sterilized feed, etc.)		
	Altered animal transport and marketing patterns (animal identification systems, feeding, watering)		
	New slaughterhouse procedures (hide wash, knife sterilization, carcass sterilizing)		
	New processing procedures (pathogen tests, contract purchasing requirements)		
	Altered product transport (increased use of time and temperature indicators)		
	New wholesale and retail practices (pathogen tests, employee training, and procedures)		
	Risk assessment modelling by industry for all links in the food chain		
	Price incentives for pathogen-reduced product at each link in the food chain		

Industry Costs² (contd)	
Outbreak costs	<ul style="list-style-type: none"> Herd slaughter/product recall Plant closings and cleanup Regulatory fines Product liability suits from consumers and other firms³
	<ul style="list-style-type: none"> Reduced product demand because of outbreak Generic animal product - all firms affected Reduction for specific firm at wholesale or retail level
	<ul style="list-style-type: none"> Increased advertising or consumer assurances following outbreak Impact of outbreaks on tourism industry
Regulatory and Public Health Sector Costs	
Disease surveillance costs to	<ul style="list-style-type: none"> Monitor incidence/severity of human disease by foodborne pathogens Monitor pathogen incidence in the food chain Develop integrated database from farm to table for foodborne pathogens
Research to	<ul style="list-style-type: none"> Identify new foodborne pathogens for acute and chronic human illnesses Establish high-risk products and production and consumption practices Identify which consumers are at high-risk for which pathogens Develop cheaper and faster pathogen tests Risk assessment modelling for all links in the food chain
Outbreak costs	<ul style="list-style-type: none"> Costs of investigating outbreak Testing to contain an outbreak (for example, serum testing and administration of IG in persons exposed to Hepatitis A) Costs of cleanup Legal suits to enforce regulations that may have been violated³
Other considerations	<ul style="list-style-type: none"> Distributional effects in different regions, industries, etc. Equity considerations, such as special concern for children

NOTES: (1) Willingness-to-pay (WTP) estimates for reducing risks of foodborne disease is a comprehensive estimate of all these categories (assuming that the individual has included employer-funded sick leave and medical programmes in their estimates). The estimate covers reduced risks for all exposed persons: those who will become ill as well as those who will not. (2) Some industry costs may fall with better pathogen control, such as reduced product spoilage, possible increases in product shelf-life, and extended shelf-life permitting shipment to more distant markets or lowering shipment costs to nearby markets. (3) In adding up costs, care must be taken to ensure that product liability costs to firms are not already counted in the estimated pain and suffering cost to individuals. However, the legal and court expenses incurred by all parties are social costs.

SOURCE: Adapted from Buzby and Roberts, 1997.

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Risk characterization is one of the four steps of microbiological risk assessment. It is defined as an estimation of the probability of occurrence and severity of known or potential adverse health effects in a population based on the preceding steps of hazard identification, hazard characterization and exposure assessment. It comprises the results of the risk assessment in the form of risk estimates and risk descriptions and provides the best available science-based evidence to support food safety management.

This volume presents guidelines for risk characterization of microbiological hazards in foods. These guidelines provide descriptive guidance on how to conduct risk characterization in various contexts, and utilizing a variety of tools and techniques. They have been developed in recognition of the fact that a reliable estimation of risk is critical to the overall risk assessment.

This volume and others in this Microbiological Risk Assessment Series contain information that is useful to both risk assessors and risk managers, including international scientific committees, the Codex Alimentarius Commission, governments and food regulatory agencies, scientists, food producers and industries and other people or institutions with an interest in the area of microbiological hazards in foods, their impact on human health and food trade and their control.

