Risk analysis for biological hazards in meat and poultry production – 2

by Dr Bob Mitchell, consultant to the food sector, UK.

As we saw in the previous article, the fact that different people can perceive risks in vastly different ways creates the need for an agreed scientific approach based on authoritative sources of information to provide a transparent evidence based food safety system.

Table 1 describes the salient differences between biological and chemical hazards.

Biological hazards

Bacterial infections

Live organisms invade and multiply to cause disease in the host. To initiate a foodborne infection, sufficient viable organisms (viruses, bacteria or parasites) must be ingested in the food.

Foodborne infections that are confined to the gastro-intestinal tract mostly present as diarrhoeal disease together with vomiting and abdominal pain. Examples include:

- Salmonella.
- Campylobacter.
- Escherichia coli (VTEC).
- Yersinia enterocolitica.
- Clostridium perfringens.

Some pathogens cause disease by spreading outside the gastrointestinal tract (extra-intestinal infections) into the blood or other organs in the body. Bacterial examples include:

- Listeria monocytogenes.
- Brucella.
- Mycobacterium.

Bacterial intoxications

Intoxications are diseases caused by the consumption of preformed toxins in the food. They are generally formed as a result of growth of the organisms in processed foods during inappropriate storage of the food, generally involving some degree of temperature abuse.

- Neurotoxins of Clostridium botulinum.
- Enterotoxins of Staphylococcus aureus.
- Emetic toxins of Bacillus cereus.

Parasites and waterborne infections

Live organisms invade and multiply to cause disease in the host. To initiate a foodborne infection, sufficient viable organisms must be ingested in the food. These are fully destroyed by cooking so are generally associated with meats eaten raw.

Control options include inspection to remove diseased animals from the food chain, cooking and freezing.

Examples include:

- Toxoplasma, Trichinella, Taenia (tapeworm).
- Cryptosporidium.
- Sarcocystis.

Prion proteins

Transmissible Spongiform Encephalopathies (TSEs) are a family of untreatable fatal diseases caused by the build-up of abnormal prion proteins in the brain and nervous system. In humans the TSE is Creutzfeldt-Jakob Disease (CJD and vCJD), in cattle it is called Bovine Spongiform Encephalopathy (BSE), or Mad Cow disease.

A similar TSE in sheep, scrapie, is not thought to be harmful to humans. There is another variant in sheep and goats, atypical scrapie, but there is no scientific evidence that it is of any risk to humans.

Prion proteins are particularly stable in chemical terms and so are resistant to denaturation by chemical and physical agents, making their destruction and disposal difficult.

Control is by the removal of infected ani-

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Table 1. Comparison of biological and chemical hazards.

Biological hazard	Chemical hazard
Hazards can enter foods at many points from production to consumption	Hazards usually enter foods in the raw food or ingredients, or through certain processing
The prevalence and concentration of hazard changes markedly at different points along the food production chain	The level of hazard present in a food after the point of introduction often does not significantly change
Health risks are usually acute and result from a single edible portion of food	Health risks may be acute but are generally chronic
Individuals show a wide variability in health response to different levels of hazard	Types of toxic effects are generally similar from person to person, but individual sensitivity may differ

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mals and contaminated materials from the food supply.

Viruses
Viruses are intracellular pathogens that cannot multiply outside host cells. Viruses implicated in foodborne diseases all have their niche in the human gastro-intestinal tract and their presence in food is a consequence of poor hygiene through water being contaminated with sewage or products being contaminated by the food handler.

The diseases caused by human enteric viruses fall into two major categories:
- Viral gastroenteritis: Norovirus.
- Viral hepatitis: Hepatitis A virus.

Other viruses of potential concern include:

Avian influenza
Avian influenza, also known as bird flu, is a disease of birds caused by type A influenza viruses which are closely related to human influenza viruses. Transmission to humans in close contact with poultry or other birds occurs rarely and only with some strains.

The potential for transformation of avian influenza into a form that both causes severe disease in humans and spreads easily from person to person is a great concern for world health.

In the most recent worldwide outbreak of avian influenza, 539 human cases and 318 deaths due to H5N1 have been reported from 15 countries which have reported outbreaks of H5N1 in poultry flocks.

To date, no epidemiological data suggest that the disease can be transmitted to humans through properly cooked food. However, in a few instances, cases have been linked to the consumption of dishes made of raw contaminated poultry blood.

Pandemic (H1N1) 2009 virus (Swine Flu)
The pandemic (H1N1) 2009 virus has not been shown to be transmissible to people through eating properly handled and prepared pork (pig meat) or other products derived from pigs. The pandemic influenza virus is killed by cooking temperatures of 70°C, corresponding to the general guidance for the preparation of pork and other meat.

Risk assessment example

A risk assessment is only a tool and can be as simple or as complex as the situation demands. Sometimes it can be as simple as 'Is the food high, medium or low risk' or it can be a complex multi-agency multi-national exercise looking at the risks to whole populations.

An example of the latter is the WHO Listeria monocytogenes in Ready to Eat Foods report. It provides an indication of the resources required to perform a formal qualitative risk assessment as well as the type of the outputs that can be expected. Note: this is the top of the range risk assessment and is the area in which governments and international bodies will operate.
- It was drafted by six scientists with assistance from seven research groups and many reviewers from over 20 countries.
- It took two years to complete and publish and is 153 pages long including appendices.

Hazard characterisation
Severe illness or death in three age-based populations were considered: prenatal/perinatal; the elderly; and an intermediate age population.

Dose-response relationships were estimated by using contamination and growth data to predict levels of L. monocytogenes at the time of consumption for all ready-to-eat foods. These data were combined with epidemiology data to derive a dose-response model for each population group.

Exposure assessment
Exposure assessments were based on estimates of the frequency of contamination of foods, the numbers of cells on ready-to-eat foods, the amount of growth before consumption, the amount of each food type consumed at a typical serving and the number of servings that were consumed per year. A survey of consumer practices, commissioned by the meat industry for hot dogs and delicatessen meats, found that:
- Most (1,300) contaminated servings of food per person per year contained less than one organism per serving.
- 19 servings contained between 1.0 and 1,000 cfu/g.
- 2.4 servings contained between 1,000 and 1,000,000 cfu/g.
- Less than one serving per person per year contained more than one million L. monocytogenes.

Risk characterisation
Individual food category data and the dose-response model were used to estimate the number of cases of illness per serving and per year for each food category and each population group. The ability of a food to support growth of L. monocytogenes to high numbers and the opportunity for growth is a key risk factor in foodborne listeriosis.

Key findings

The model indicates that it is the few servings with very high levels of contamination that are responsible for most of the illnesses and deaths. The vast majority of cases of listeriosis are associated with the consumption of foods that do not meet the current standards for L. monocytogenes in foods, whether that standard is zero tolerance or 100 cfu/g. ■

Details of authoritative sources of information are available from the author on request.

✉ bobmitchell7@btinternet.com