Risk, food safety and the need for the science of risk analysis – 1

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This series of three articles will introduce the science of risk analysis as applied to meat and poultry products. The next two articles in the series will cover microbiological and chemical hazards in meat.

When I am delivering training courses on risk analysis I constantly receive requests for information on hazards, their occurrence and other characteristics associated with specific foods. Hence, in these articles I will focus on authoritative peer reviewed sources of information particularly the guidance from the Codex Alimentarius Commission (CAC), the internationally agreed standards for scientific aspects of food safety. EU legal requirements will be covered where appropriate. We all think that we understand the term 'risk'. However, using the word 'risk' is risky, being complicated by three major factors:

- Risk means different things to different people.
- People find it difficult to really understand probabilities.
- The concept of risk has a large psychological component that impacts heavily on how people respond to any given risk.

What is risk?

Risk means different thing to different people. To some it means 'harm' to others it means 'the probability of the harm occurring' while to others it can mean 'both the probability of the harm occurring and how severe it will be'. The CAC guidance defines risk and hazards as:

- Risk: A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard in food. (In plain English risk is both the chance that the hazard will make someone ill and how severe that illness will be.)
- Hazard: a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

In real life, risks are much more than merely expressions of probability or severity of harm. Table 1 lists some of many facets that need to be considered when talking about risk.

Prefixes:	Relative, Acceptable, High, Low, Qualitative, Quantitative
Suffixes:	Factor, Assessment, Analysis, Management, Communication, Behaviour, Perception, Ratio, Based, Reduction, Aware, Averse
Risk of what:	Harm, Illness, Death, Loss of business, Loss of sales, Loss of job
Risk to whom:	Population, Industry sector, Individual business, Individual, Vulnerable groups, Other subgroups
Expressed as:	High risk, Low risk, per 100,000 of the population, per 100,000 servings, per serving.
Outrage factors:	Is the risk voluntary? Impact on vulnerable groups, Do I have any control over it? Fairness: are we all equally exposed to the risk? Is the agency in control trustworthy? Dread: 'mad cow disease', 'frankenstein foods'
Media triggers:	Blame, Cover ups, Human interest, Links to high profile issues or personalities, Conflict between experts or others, Further problems (what next?), Many people at risk (it could be you), Visual impact: pictures of the victims, especially children, Links to sex or crime (hopefully not too common for foods).

Table 1. Different facets of risk.

The first two rows list the prefixes and suffixes that can modify the type of risk one is talking about. The next three rows illustrate differences in the nature of the risk; who is affected by it; and different ways of expressing the risk.

So you see that two people talking about 'risk' might be talking about very different things unless they are specific and qualify what they mean by stating: 'The risk of what to whom'.

To complicate matters further, human beings deal with risks using more than just their intellect. Given the critical importance of food to our very survival it is no surprise that food related risks evoke a strong emotional response that can be equal to, or bigger than, mere intellectual judgement alone.

This emotional response is termed 'risk perception' and is a science all in itself. There are a number of triggers, called 'outrage factors' that have the potential to magnify a person's response to a perceived risk. Chief of these is the question 'Is the risk voluntary'.

In general, we are more willing to accept risks that we have chosen for ourselves than similar risks foisted upon us by others. Think of the difference in attitude between a driver and a passenger when the car is driving too fast and too close to the car in front. Another powerful outrage factor arises when vulnerable groups are at risk. This explains the powerful response of the public to situations where children or babies are affected, for example salmonella or dioxin in baby milk powder.

Table 1 lists some outrage factors, of which at least 47 have been identified by psychologists. Closely related to outrage factors are the media triggers that have the potential to elicit a response to a particular risk-related issue. Again, note the importance of vulnerable groups.

An additional emotional factor is the inability of the general public to relate to numerical expressions of probability, which they never experience in their day to day lives. Hence, when experts express risk in terms of probabilities it often fails to reassure the public. Similarly, risk comparisons can be doomed to failure. Comparing a food safety risk event to the chances of being struck by lightning is useless because most people have never been struck by lightning.

A final complicating factor is the body of scientific evidence which shows that in terms of food safety risks expert acceptance of risk is simply totally different from that of

the general public. In the light of these complex inter-related risk perception issues there is a need for an agreed transparent systematic approach to assessing, managing and communicating about risk. This is the science of risk analysis.

The science of risk analysis

The most useful guidance for food safety risk analysis is produced by the Codex Alimentarius Commission.

Risk analysis is a scientific process for assessing, managing and communicating about risks. It has three components:

- Risk assessment is the scientific process for assessing risk in foods.
- Risk management is the scientific process for weighing up options for controlling the risks under consideration. Control options include GHP, HACCP, and end product analysis as do providing advice to consumers, or even withdrawing foods from sale.
- Risk communication is the interactive exchange of information and opinions throughout the whole risk analysis process among all interested parties including the explanation of risk assessment findings and the basis of risk management decisions.

Risk assessment is the scientific process for determining the chance that the hazard will do damage and how bad will that damage be. It can be qualitative of quantitative. It has four components.

- Hazard identification. What will do the harm?
- Exposure assessment. How much of the hazard will be eaten?
- Hazard characterisation. What will the effect be?
- Risk characterisation. How likely is it that harm will be done and how severe will the effects be?

The key benefits of following this system include:

- Using a structured science-based approach to analysing risks rather than relying on 'feelings' or 'opinions'.
- Decision making becomes transparent by showing the factual basis on which decisions are made. This includes assumptions, sources of uncertainty, information gaps and constraints such as time and resources that might have limited the assessment.
- Risks can be prioritised so that the most serious risks can be dealt with first.
- Risks can be managed and communicated to others.

	Purpose	Output
Government	Set priorities for action	Prioritised action plans
	Draft risk-based legislation	Risk-based legislation
	Settle disputes over technical barriers to trade	Judgements and agreements based on science
	Determine 'safe' or 'acceptable' limits for hazards in foods and food safety objectives	Critical limits for industry HACCP, microbiological standards, food safety objectives, micro standards
	Identify gaps for R&D	Targeted R&D programmes
Enforcement	Set priorities for action	Prioritised action plans
	Prioritise inspections	Prioritised inspection schedules
	Enforce risk-based legislation	Appropriate enforcement activities
Industry	Set priorities for action	Prioritised action plans for hazard management
	Determine hazards, critical limits and target levels for HACCP	Practical, effective HACCP systems. Commercial microbiological criteria based on science and knowledge of own operations and products
	Risk communication with consumers	Communication strategy for potential crises

Table 2. Typical uses and outputs from risk assessment.

- This approach can help demonstrate compliance with risk-based legislation to regulators and to customers.
- The principles can be applied to any risk in any food at any part of the food chain and even to theoretical risks allowing for consideration of future potential problems.

Table 2 shows some of the typical uses and outputs from risk analysis. It is very much a summary. 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 multinational exercise looking at the risks to whole populations. An example of the latter is discussed in the next article.

Hazards in more detail

The purpose of the hazard identification stage in risk assessment (and the hazard analysis step of HACCP) is to identify the micro-organisms, microbial toxins, chemicals or physical agents in a food that can do harm to the consumer. Examples of common hazards are listed Table 3.

Physical hazards are myriad and are generally managed by Good Hygienic Practice (GHP) but they can also be integral to the HACCP plan depending upon the product and process under consideration. Control measures include source control, for example vendor certification and raw-material testing; or production control, for example metal detectors and visual inspection.

Authoritative information on any hazard can be obtained from relevant data sources like the scientific literature; from databases such as those in the food industry, government agencies, and relevant international organisations; and from consultation with experts. Relevant information includes data from clinical and epidemiological studies and food surveillance.

Table 3. Examples of hazards that can occur in foods.

Biological hazards:	Infectious bacteria, Toxin-producing organisms, Moulds, Parasites, Viruses, Prions
Chemical hazards:	Naturally occurring toxins, Food additives, Pesticide residues, Veterinary drug residues, Environmental contaminants, Chemical contaminants from packaging, Allergens
Physical hazards:	Metal, Machine filings, Glass, Jewellery, Stones, Bone chips

EU legal requirement

Although there is no explicit legal requirement for risk analysis there is much implicit reliance on it. Most food safety legislation throughout the world, including Regulation EC 852/2004, is geared towards taking a more flexible and risk based approach (rather than the old fashioned 'walls floors and ceilings' approach).

Article 5 requires food business operators to implement and maintain a permanent procedure or procedures based on the HACCP principles. Clearly, this requires some form of risk analysis in order to: identify hazards and 'acceptable levels' of risk; determining appropriate parameters for monitoring and setting critical limits; as well identifying pertinent corrective actions and verification procedures. ■

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

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