Chapter 13

Food without Zoonotic Agents: Fact or Fiction?

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Over the last decades considerable investment has been made to produce safe food. In many industrialised countries food is safer than ever before due to continuous efforts, but this can never be taken for granted. Some existing microbiological food safety problems still remain a challenge; well-known pathogens may be transmitted by hitherto unknown vehicles and new pathogens will continue to emerge. Many factors influence the changing epidemiology of pathogens and their emergence is only partly predictable or explainable. The majority of foodborne pathogens have their reservoir in the animal population. Therefore, one of the keys for future preparedness to detect new trends, to implement control measures and to predict the effect of interventions is intersectoral collaboration between animal health, the food sector and public health.

Introduction

Zoonotic diseases are a group of infectious diseases that are naturally transmitted between vertebrate animals and humans (*www.who.int/topics/zoonoses/en/*). A literature search showed that more than 800 human pathogens are zoonotic (Taylor *et al.*, 2001; Woolhouse and Gowtage-Sequeria, 2005). The majority of these infections originate from wildlife. Transmission to humans may occur through a variety of transmission routes including food, the environment, and direct animal contact. Secondary spread may occur through human-to-human transmission. Foodborne zoonotic diseases are a public health concern worldwide (Anonymous, 1984).

Certain zoonotic pathogens have been well known for a long time and are still a persisting problem in many areas of the world. Examples of these pathogens are non-typhoidal *Salmonella* (*e.g. S. Enteritidis, S. Typhimurium*), *Brucella* spp., and *Bacillus anthracis*. Examples of pathogens that were detected relatively recently (the last third of the 20th century) are *Campylobacter* spp. (causing mainly gastro-intestinal problems but also neurological and rheumatological disorders in humans), *E. coli* O157 (causing diarrhoea in humans and HUS – Hemolytic Uremic Syndrome – mainly in children), and Transmissible Spongiform Encephalopathy (the BSE prion in cattle as cause of the variant Creutzfeldt–Jakob disease in humans).

Zoonotic pathogens that have been detected recently are referred to as emerging zoonoses. According to the definition given by World Health Organization (WHO) these are "zoonoses that are newly recognised or newly evolved, or that have occurred previously but show an increase in incidence or expansion in geographic, host, or vector range" (Anonymous, 2004). Over the last 20 years, 73% (114/156) of all emerging human infections are zoonotic (Taylor *et al.*, 2001). The emerging zoonoses are a major concern as they pose a significant burden on global economies and public health. A recent example of an emerging zoonosis originating from wildlife and spreading rapidly through the human population in various parts of the world is SARS (Drosten *et al.*, 2003). In addition to the threat of the emerging infectious diseases, pathogenic organisms resistant to antimicrobials continue to emerge, caused by both human and non-human antimicrobial usage, leading to increased morbidity and mortality through treatment failure.

The global burden of foodborne diseases is largely unknown. Virtually no data on morbidity and mortality of foodborne diseases exist in large areas of the world. The WHO has recently launched a new initiative to estimate the burden of foodborne diseases on a global scale (Stein *et al.,* 2007).

Control of infectious diseases

Several foodborne infectious diseases have been successfully controlled over the last century, in particular in industrialised countries. Data from the USA shows that five pathogens that were major causes of foodborne disease before 1900 (*Brucella* spp., *Clostridium botulinum*, *Salmonella* Typhi, *Trichinella* spp. and toxigenic *Vibrio cholerae*) account for only 0.01% of the disease cases and less than 1% of the deaths in 1997 (Tauxe, 2002). This reduction over time can be explained by the implementation of general and specific control measures. In general, the improvement of sanitation (municipal water supply, sewage systems) has contributed enormously to the control of infectious diseases. Pasteurisation of milk and other food products has reduced tuberculosis and brucellosis in humans. Control measures along the food chain (pre- and post-harvest) have reduced the burden of foodborne diseases. The consequences of a failing control system are illustrated by the biggest *Salmonella* Typhimurium outbreak ever reported that happened in Illinois (USA) in 1985. It was estimated that between 168 791 and 197 581 people were affected (Ryan *et al.*, 1987) due to a *Salmonella* contamination in a single production plant.

Besides the success-stories on aforementioned pathogens, other pathogens like *Campylobacter* spp. are much harder to control (Wagenaar *et al.*, 2006). Also, we have to realise that the implementation of effective control measures for foodborne diseases is usually reported from industrialised countries. Due to economic and logistic constraints implementation of interventions in developing countries is much more difficult.

(Re)emerging infectious diseases

The change in epidemiology and (re)emergence of foodborne pathogens is influenced by many factors (Todd, 1997; Havelaar *et al.*, 2010). A selection is listed below.

International trade and travel: there is a growing international trade of food. This may facilitate the spread of infectious agents and antimicrobial resistance around the globe. Outbreaks with a common contamination may occur in several countries at the same time. Increasing travel of people increases the risk of acquiring “foreign” pathogens (Sirichote *et al.*, 2010). People may come in contact with organisms to which they have not been exposed earlier and are immunologically naive. For *Campylobacter* these aspects of immunity have been reviewed (Havelaar *et al.*, 2009).

Changing consumer lifestyles, habits and demands: compared with the situation in the second half of the 20th century, consumers chose increasingly fresh, minimally processed or ready-to-eat foods. These food items pose a greater risk for foodborne diseases (*e.g.* *Listeria* and *Yersinia* in ready-to-eat foods kept in the refrigerator, sporeforming micro-organisms that survive minimal processing).

Susceptibility of hosts: the number of people with an impaired immune system is increasing due to the further developed life saving health care of premature children and the increase of the population of elderly (Ohlsen and Hacker, 2005). This will lead to an increased susceptible fraction of the population.

Changing animal production systems: starting in the 1950s animal production systems changed into more large-scale indoor kept animals. From a biosecurity point of view (prevention of contact with wild animals, prevention of pathogen introduction) this was a positive development. However, increased attention to animal welfare and focus on sustainable production systems have led to more extensive farming and organic production. These systems have more outdoor production and potential contact with wildlife with consequently the re-introduction of *e.g*. *Trichinella spiralis* and *Toxoplasma gondii* (Kijlstra *et al.*, 2009). In poultry almost all flocks with outdoor access are colonised with *Campylobacter* spp., whereas for poultry kept in more biosecure housing systems the prevalence of *Campylobacter* colonised flocks is lower (Näther *et al.*, 2009)

Improved diagnostics: some pathogens were previously not detected due to the lack of detection methods. One example is *Campylobacter*, a pathogen that was most probably “always” present but only detected in human stools after the development of sensitive and selective detection media in the 1970s (Butzler, 2004). Even with the same occurrence of pathogens, the introduction of improved diagnostic assays can suggest an increased prevalence of disease.

Changing microbes: not only is the world around the microbes changing but also the microbes themselves. Verotoxin containing *E. coli* (*e.g. E. coli* O157) is an example of a pathogen that evolved from an *E. coli* after acquiring additional virulence traits (verotoxic genes) resulting in a pathogen causing severe disease. Another example is the worldwide alarming increase in antimicrobial resistance in bacterial pathogens. This development is the result of the use of antimicrobials in animals and humans. As this is a major risk for public health, the prudent use of antimicrobials must be advocated.

Climate change: the association of climate change and the changing epidemiology of infectious diseases is extremely complex. Changes in water supply (shortage *versus* floodings) can have a huge impact on the food supply and contamination of food and therewith on the epidemiology of pathogens.

Challenges in the control of foodborne diseases

The reason why, when and where formerly unknown pathogens are introduced into the human population is influenced by a large and complex set of factors. Therefore, the (re)emergence of pathogens seems to be rather unpredictable. However, an analysis of 335 emerging infectious diseases between 1940 and 2004 showed that the emergence is a non-random process. There is an association with socio-economic, environmental and ecological factors (Jones *et al.*, 2008). This analysis provides the basis for the identification of regions where emerging infectious diseases are most likely to originate ("hot-spots"). Newly developed tools (*e.g.* molecular typing, predictive mathematical modelling, and understanding of adaptation of microbial pathogens) may identify risks more precisely and support risk assessment of pathogens (Havelaar *et al.*, 2010).

Although theoretical science-based predictions are of great value, the monitoring of contamination in the food chain, combined with surveillance of human illness and epidemiological investigations of outbreaks and sporadic cases continue to be important. Monitoring and surveillance provide data on (changing) trends, have an early warning function and will potentially detect emerging infections.

International co-operation and communication

International co-operation and communication are essential to develop an effective control strategy for foodborne diseases. International organisations (*i.e.* WHO, FAO, and the World Organisation for Animal Health (OIE)) have developed supranational information systems for the detection and timely reporting of infectious diseases and contaminants. These systems include the International Health Regulations (IHR) (human infectious diseases), the International Food Safety Authorities Network (INFOSAN) (food contamination) and The Global Early Warning and Response System (GLEWS) (major animal diseases, including zoonoses). As there is a major threat from the animal reservoir for (re)emerging zoonoses, the collaboration between the veterinary sector, food sector, and public health are crucial in addressing zoonotic risks (Newell *et al.*, 2010).

An integrated approach to food safety and zoonoses: global foodborne infections network

Due to the nature of zoonotic infections in animals and contamination of foods, visual inspection is not enough to prevent the spread of infection between animals and to ensure safe food and ingredients. Laboratory-based surveillance of animals, food and humans is important, both to detect and prevent foodborne pathogens from entering or spreading through the food chain, as well as to identify foodborne disease outbreaks so that appropriate control measures can be taken.

Many countries still lack the necessary surveillance capacity for outbreak detection and response. In addition, foodborne disease outbreaks go undetected, in part due to lack of communication between the human, veterinary, and food sectors. Due to the globalisation of animal and food trade, national issues can have global implications. It is, therefore, imperative that countries are able to detect and deal with clusters of foodborne pathogens and disease.

In 2000, WHO initiated WHO Global Salm-Surv (GSS), now called Global Foodborne Infections Network (GFN), to enhance countries' capacities to conduct integrated surveillance for foodborne and other enteric infections from the farm to the table. Recognising that zoonotic risks require multi-sectoral co-operation and strong partnerships with strong linkages between human and animal detection and response systems, GFN promotes integrated, laboratory-based surveillance, and fosters intersectoral collaboration and communication among microbiologists and epidemiologists in human health, veterinary, and food-related disciplines.

Conclusion

We conclude that food production systems are continuously challenged by existing and (re)emerging pathogens. Food production should aim for safe products but the reality dictates that zero risk is non-existent. Therefore monitoring and surveillance systems should be in place worldwide to detect and respond to food safety events. Implementation of these systems is required to reduce the burden of foodborne diseases in developing and industrialised countries.

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