# Laboratory surveillance for prevention and control of foodborne zoonoses

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**Summary.** Foodborne infections are an important Public Health concern worldwide. Most of the pathogens that play a role in foodborne diseases have a zoonotic origin. The epidemiology of foodborne infections as well as the food production and distribution chains, have remarkably changed during the past ten years. Understanding of how pathogens arrive, persist in animal reservoir or enter the food chain is a crucial step in prevention strategies. These need to be aimed to measure the overall impact of the infections, to identify trends in incidence and to to recognise rapidly outbreaks also at transanational level. Enter-Net is an example of an international laboratory based surveillance network which contribute largely to European foodborne zoonosis surveillance.

*Key words:* zoonoses, food safety, laboratory surveillance, Europe.

**Riassunto** *(La sorveglianza di laboratorio per la prevenzione e il controllo delle zoonosi trasmesse da alimenti)*. Le infezioni di origine alimentare rappresentano una tematica di rilevanza mondiale. La maggior parte dei patogeni responsabili di tossinfezioni alimentari ha origine zoonosica. Negli ultimi dieci anni sono intervenute profonde mutazioni della filiera produttiva, nella distribuzione dei prodotti di origine animale e nell'epidemiologia di tali infezioni. L'identificazione delle modalità di infezione dei serbatoi animali e di contaminazione della filiera costituisce un punto chiave per le strategie di prevenzione. Queste devono essere finalizzate alla valutazione dell'impatto complessivo delle infezioni, all'identificazione dei trend d'incidenza e al riconoscimento tempestivo dei focolai epidemici anche a livello transnazionale. Enter-Net è un esempio di rete internazionale di sorveglianza di laboratorio che contribuisce alla sorveglianza europea delle zoonosi trasmesse da alimenti.

*Parole chiave:* zoonosi, sicurezza alimentare, sorveglianza laboratorio, Europa.

## INTRODUCTION

Foodborne infections are an important Public Health concern worldwide, and both World Health Organization and the US Centers for Disease Control and Prevention [1, 2] report every year a large number of people affected by diseases due to contaminated food consumption.

Most of the pathogens that play a role in foodborne diseases have a zoonotic origin and have reservoirs in healthy food animals, from which they spread to an increasing variety of foods. Therefore, foods of animal origin are considered major vehicles of foodborne infections [3].

Well established foodborne pathogens like *Mycobacterium bovis* or *Trichinella spp*. have been controlled or eliminated in industrialized countries. However, many other zoonotic pathogens have been newly described or newly associated with food transmission within the last 25 years [4].

As in the case of cattle carrying *E. coli* O157 or layer hens carrying *S. Enteritidis*, the animal reservoirs are usually not affected by these pathogens. The trade of infected healthy animals has facilitated the global spread of many zoonotic agents. Therefore, surveillance must consider monitoring of healthy animal populations and public health concerns must include events happening around the world.

Another important issue common to many emerging zoonotic pathogens is antimicrobial resistance, largely because of the widespread use of antibiotics in the animal productions [5]. *Campylobacter spp*. strains isolated from either human patients or poultry are increasingly resistant to fluoroquinolones, after these agents were introduced for use in animals [6]. Multiresistance has become an hallmark of *Salmonella* serotypes such as *S. typhimurium, S. Blockley, S. Hadar* [7]. Therefore, public health concerns must include the improvement of prudent use of antimicrobials in husbandry productions.

The identification rate of new pathogens, during the last years, suggests that more zoonotic agents will emerge in the future.

The epidemiology of foodborne infections has dramatically evolved during the last 20 years and the laboratory characterization of the microorganism in-

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volved has largely contributed to the investigation of the ecology (environmental characteristics, reservoirs and transmission routes), mechanism of pathogenicity, antibiotic resistance and finally to the study of spatial and temporal distribution of the zoonotic agents, including the identification of outbreaks.

This paper discusses main trends in the evolution of foodborne zoonoses and the role of laboratory surveillance in their prevention and control.

## EMERGING FOODBORNE INFECTIONS

The epidemiology of foodborne infections in industrialized countries has remarkably changed during the past ten years and an increasing number of unusual food vehicles have been associated with human infections. Many of these foods were previously considered safe from a microbiological point of view. Dry fermented sausages, considered safe for their low pH and water activity, have been associated with outbreaks of *E. coli* O157 and *Salmonella* infections. The marked acidic and evironmental resistance of *E. coli* O157 [8] also allowed the organism to survive in apple cider and dried venison jerky. The internal contamination of intact eggs with *S. enteritidis* is a consequence of the peculiar biologic niche of this *Salmonella* serotype in egg-laying flocks [9].

The dispersion of untreated animal dejections in the environment can cause the contamination of different items, which can then act as secondary vehicles of human infections [10]. An increasing spectrum of fruits and vegetables fertilized with animal feces or contaminated during harvesting or processing has been involved in outbreaks [11]. Contaminated sprouts have caused episodes of salmonellosis and represent an emerging source of *E. coli* O157. Raspberries contaminated with *Cyclospora* caused an epidemic in the United States in 1996 [12]. Other fresh produce like lettuce, tomatoes, coleslaw, and berries [10, 11] are established or potential vehicles of Shiga-toxin producing *E. coli* (STEC) infection. Unpasteurized fruit juices, increasingly popular among consumers, represent another safety concern. Apple juice, in particular, has been frequently involved in *E. coli* O157 outbreaks [10, 11].

Moreover, foodstuffs are increasingly produced globally, and have to respond to the public demand for cheaper food, food out of season, and more exotic food experiences. Such food frequently comes from developing countries and its safety strongly depends on local quality control systems.

The modifications in the food production and distribution chains also have dramatically changed the traditional scenario of foodborne outbreaks. These outbreaks typically occurred in limited settings (social event, families, schools), with high attack rates, and were usually due to errors in food-handling shortly before consumption. They were easily recognized, first by those directly involved in the episode who usually involved medical and public health authorities. Conversely, an increasing number of large and diffuse outbreaks, involving large geographic areas and even different countries, is now observed [4]. These outbreaks are often the result of low-level contamination of a widely distributed commercial food item. They are difficult to detect, since the increase in cases may be not apparent against the background of sporadic cases. Detection often relies upon careful reviewing of laboratory surveillance data.

## SURVEILLANCE AND CONTROL STRATEGIES

Preventing foodborne diseases is a multi-factorial process. Understanding the mechanisms by which contamination can occur along the chains of production and the ways that infections can be transmitted to human beings should be the basis for any prevention strategy. Prevention can be achieved by identifying and controlling the key steps, from the farm to the dinner table, at which contamination can either occur or be reduced. The general strategy known as Hazard Analysis and Critical Control Points (HACCP) has replaced the strategy of final product inspection. Moreover, traditional food inspection, which mainly relies on visual identification of hazards, is often not adequate to detect contamination with the new foodborne zoonotic agents, which requires new control strategies, mainly based on laboratory analyses.

Prevention of foodborne zoonoses must begin at the farm level. Therefore, understanding of how pathogens arrive to and persist in animal herds is a crucial step in prevention strategies. Controlling contamination of feed and water consumed by animals is an important part of such strategies.

Finally, consumer education about basic principles of food safety remains an important component of prevention.

## MONITORING AND SURVEILLANCE

Public health surveillance of foodborne zoonoses has three main distinct objectives: i) to measure the overall impact of the infections; ii) to establish trends in incidence; iii) to recognize outbreaks rapidly in order to take effective public health measures.

Although a surveillance system may be adequate for establishing trends in incidence, effective outbreak recognition requires high sensitivity and timeliness, in which as many isolates of the zoonotic agents as possible are fully characterized and data are collected and analyzed in a short time. The speed at which such outbreak can be recognized depends on the speed and frequency which strains are referred for characterization, and on the speed which strain-characterization data are assembled within national (or international) databases and analyzed. Day-to-day monitoring of typing data should be required, together with rapid communication to all involved.

The prevailing practice within the EU is to base the surveillance of foodborne zoonoses upon laboratory confirmed isolates of the relevant organism.

## LABORATORY BASED SURVEILLANCE

The main clinical manifestation of foodborne infections is diarrhea, and the clinical syndromes caused by the different foodborne pathogens are usually not distinguishable. As a consequence, reporting of disease episodes without the indication of the etiologic agent will not distinguish agents (bacteria, protozoa, viruses) with different epidemiologic cycles, different animal reservoir and different routes of transmission.

Therefore, national control programs for foodborne zoonoses should be laboratory-based, and networks of designated National Reference Laboratories capable of a full characterization of the agents should be implemented. For widespread agents like *Salmonella* or STEC, characterization of the isolates by serotyping and phagetyping is essential for epidemiologic purposes. Molecular typing methods have largely increased the capability of tracing back zoonotic infections from the human disease episodes to the animal sources or food veichles. Identification of clusters of isolates of a given pathogen can be crucial for identifying large, dispersed outbreaks in the community.

International laboratory based surveillance networks related with foodborne zoonoses have been established [13, 14]. They allow rapid international communication for both public health and research issues, and their public health value is now widely recognized. However, they are often limited to human public health and do not include veterinary aspects.

## THE EC INTERNATIONAL SURVEILLANCE NETWORK FOR THE ENTERIC INFECTIONS, ENTER-NET

Enter-Net is an established and thriving EU wide network for the surveillance of human *Salmonella* and STEC infections which include microbiologists responsible for national reference services in every EU country. Many of the laboratories in the network also provide national reference services for human *Campylobacter* infections. Data from all EU countries [15] are regularly collected and efficient communication and collaboration within the network allow rapid identification of outbreaks. The recognition of international outbreaks, and the subsequent investigations, is a major objective of Enter-Net. In several circumstances, information on a fully characterized isolate from a food item, supplied by a national center in response to a network enquiry or to an outbreak detection, has immediately suggested the probable source of a newly recognized outbreak.

Finally, concerted research within Enter-Net has produced unified European phage-typing schemes for the principal *Salmonella* serotypes, and antibiotic susceptibility testing has been calibrated across national reference laboratories.

## CONCLUSIONS

Having animals and raw products free from zoonotic agents is not achievable in practice. However, the occurrence of zoonoses can be minimized by applying high standards of hygiene in all the steps of the food production chain. The public health food safety infrastructure can be enhanced by laboratory-based surveillance strategies, and international surveillance networks can facilitate information exchange and prompt response to transnational emergencies. However, a higher degree of integration between medical and veterinary surveillances would be needed. Integrated laboratory surveillance of foodborne zoonoses should provide policy makers and other stakeholders scientific information and advice on minimizing the risks of human illnesses, arising from animals and the environment, with special emphasis on infections due to enteric pathogens.

The integration of animal health, food safety and environmental data with human enteric disease data will provide an added value in terms of public health and also for the better comprehension of the epidemiology of these zoonotic diseases.

Finally, implementing basic and applied research on the causative agents of foodborne zoonoses will be crucial for new approaches to their prevention and control.

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