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FOOD CONTAMINATION MONITORING AND FOOD BORNE DISEASE SURVEILLANCE AT NATIONAL LEVEL

(Paper prepared by Lo Fo Wong DMA[1], Andersen JK[2], Nørrung B[2], Wegener HC[1])

ABSTRACT

Cost-efficient monitoring of food contamination and surveillance of food borne diseases requires a coordinated multidisciplinary approach with the participation of stakeholders from all sectors of the "farm-to-fork" continuum including the public health sector. To facilitate communication and coordination, establishment of a coordinating body with the participation of relevant stakeholders is recommended. Furthermore, relevant surveillance data from all stages in the food production chain and from the surveillance of human disease should be continuously collected and analyzed to evaluate trends and sources of food borne disease. The establishment of a dedicated multidisciplinary surveillance unit involving epidemiological and microbiological expertise from all sectors can facilitate this type of coherent data analysis and feed back. Systems such as these can be operated at the national, regional and global level.

MONITORING AND SURVEILLANCE AS TOOLS IN FOOD SAFETY ASSURANCE

In order to address and manage food safety, it is imperative to have knowledge on the current situation and trends with regard to the occurrence and spread of human pathogens in the food production chain. This knowledge needs to be updated continuously so that appropriate responses can be prepared. Activities involved in such a system are gathered under the terms 'monitoring' and 'surveillance' (Fig. 1). Monitoring can be defined as: "*the performance and analysis of routine measurements, aimed at detecting changes in the environment or health status of populations*". Surveillance can be defined as: "*the ongoing systematic collection, collation, analysis and interpretation of data, followed by the dissemination of information to all those involved so that directed actions may be taken*" (WHO/CDS/CSR).

Surveillance refers to a specific extension of monitoring where obtained information is utilized and measures are taken if certain threshold values related to disease status have been passed (Noordhuizen and Dufour, 1997). The main objectives of surveillance are outbreak detection, monitoring trends in endemic disease, evaluating interventions, and monitoring programme performance and progress towards a predetermined control objective. However, surveillance is not merely a routine measure of the current situation (as opposed to monitoring), but a basis for giving qualified feed-back to

1 Dept of Epidemiology and Risk Assessment
2 Dep. of Microbiological Food Safety, Danish Institute for Food and Veterinary Research, Mørkhøj Bygade 19, DK-2860 Søborg, Denmark

producers, tracing back contamination to its origin, pin-pointing critical (control) points during production and initializing targeted action.

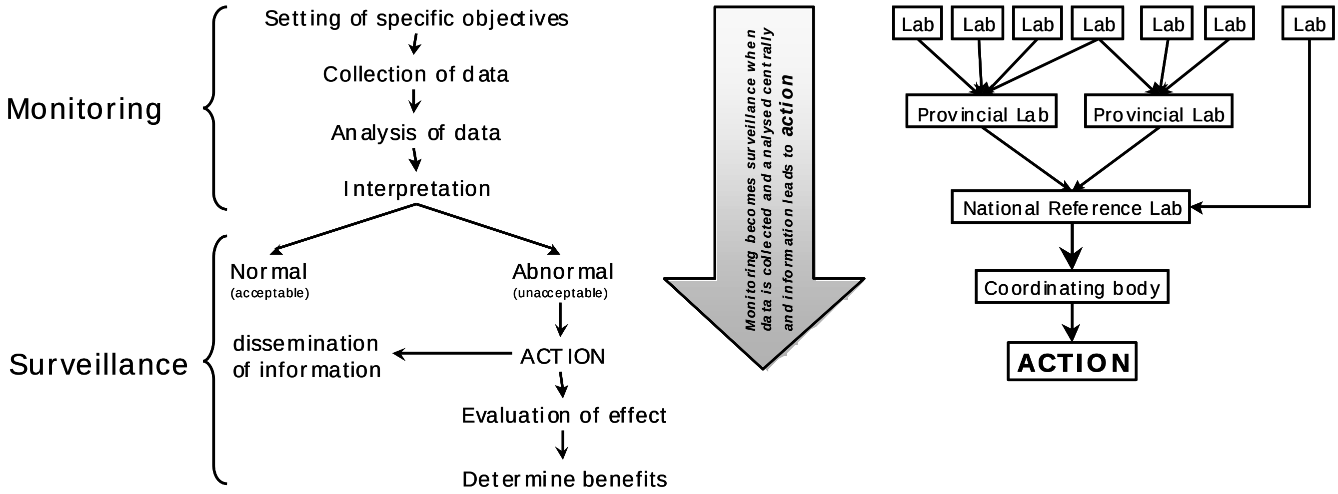


Figure 1. Graphic presentation illustrating the relation between monitoring and surveillance.

There are various levels of intensity and coordination in surveillance systems. Surveillance can be active or passive, general or sentinel, continuous or intermittent, disjointed or integrated. In general, the intensity of surveillance is a product of social (i.e. priority of disease, societal impact), practical (i.e. availability of epidemiological knowledge) and financial parameters.

THE NEED FOR A NATIONAL APPROACH

Pathogenic microorganisms can enter the food chain at any point, from livestock feed, via the on-farm production site, at the slaughterhouse or packing plant, in manufacturing, processing and retailing of food, through catering and home preparation. Since there are numerous possible routes for transmission of pathogens throughout production, isolated actions (e.g. decontamination of animal feed) will in most cases not ensure lasting consumer protection. In order to effectively manage the problem of food borne disease, measures should be considered at all levels of production. This requires a coordinated surveillance and response effort from all major stakeholders in food safety.

The food industry is responsible for the quality and the safety of their products and is therefore a major stakeholder in food safety. Production may be monitored through, for example, certification programmes, process control schemes or HACCP (Hazard Analysis Critical Control Points) based control programmes. These control activities generate data that can constitute an important contribution to national surveillance programmes. Also, in an outbreak investigation, additional sampling may be required to trace-back human infection to the point of contamination in the food-production chain. Close cooperation between the private and public sector is therefore imperative.

In general, the main stakeholders in food safety representing the government are the Ministries of Health and the Ministries of Agriculture/Food. Under them are agencies that are responsible for the legislative, technical and practical implementation of food safety programmes, and each agency often has a dedicated reference laboratory associated with it. The access to surveillance data often goes through these laboratories. These two or possibly three organizational structures often run independent of each other. In order to get a comprehensive view of the national food safety status, the two Ministries and their respective agencies and reference laboratories should work closely together.

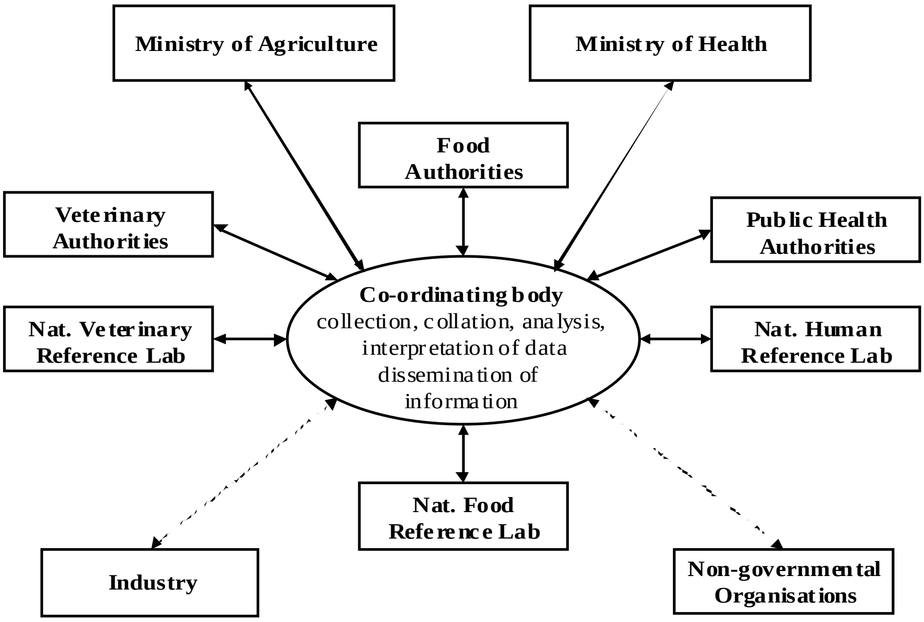


Figure 2. Schematic presentation of the collection, collation, analysis and interpretation of surveillance data and the subsequent dissemination of information to all the major stakeholders in food safety.

Finally, other stakeholders of food safety are the non-governmental organizations. They may represent consumers, food industry workers or the environmentalists. Although these organizations seldom are directly involved in the generation of data, they can influence the launching of food safety initiatives and serve as a driving force behind initiation of surveillance efforts.

The main challenge is to develop structures that ensure the systematic collection, collation, analysis and interpretation of surveillance data and communication to all public and private stakeholders involved (Fig. 2). For this purpose, one or more coordinating bodies or steering committees with representatives of all stakeholders may be formed. The integration of all surveillance data from farm-to-fork in a coherent analysis and subsequent interpretation may be the task of a specialized multidisciplinary research unit, which reports to the relevant coordinating bodies or steering committees. The evaluation by these committees can then lead to a coordinated response.

Integration of surveillance activities to the national level facilitates optimization and cost efficiency in the generation and utilization of surveillance data. The challenge is to optimize the sensitivity of the surveillance system while minimizing the costs. For example:

- Integration of surveillance components within and between links of a production chain, e.g. to investigate possible associations between the levels of food borne pathogens in food animals and in food products at retail;
- Integration of different surveillance programmes of the same production animal, e.g. using the same serum samples for the detection of antibodies against both Salmonella and PRRS;
- Integration of different surveillance programmes for different production animals, e.g. to estimate the relative contribution of the main reservoirs to the total number of human cases of food borne illness;

- Integration of national surveillance programmes to rapidly recognize and report international outbreaks, e.g. EnterNet, OzFoodNet and Global SalmSurv.

The integration of food borne disease surveillance activities can be achieved through: 1) communication, 2) collaboration, 3) coordination and 4) central storage of data. Communication between major stakeholders can be maintained during regular meetings and direct, informal contact between veterinary and public health workers in key-positions. Collaboration consists mainly of the routine exchange of data and participation in outbreak investigation and response. Control activities and the sharing of information need to be coordinated, within and between programmes. Managing a central database containing all surveillance data allows for coherent analyses of the relation between food borne-pathogen reservoirs and disease in time and space. These four components ensure the optimal use of data that already is being generated.

THE ROLE OF NATIONAL MONITORING AND SURVEILLANCE IN RISK ANALYSIS

Though the main purpose of surveillance is disease control, surveillance data is widely used as part of a risk analysis framework (i.e. in risk assessment and risk management) (Fig. 3). Surveillance programme outcome allows for the detection of events and developments that require a detailed evaluation of the situation (i.e. risk evaluation). By incorporating results from all pertinent lines of investigation (e.g. monitoring and surveillance programmes, outbreak investigations, surveys, analytical studies), risk assessors can develop risk models that are used to evaluate alternative intervention and control strategies.

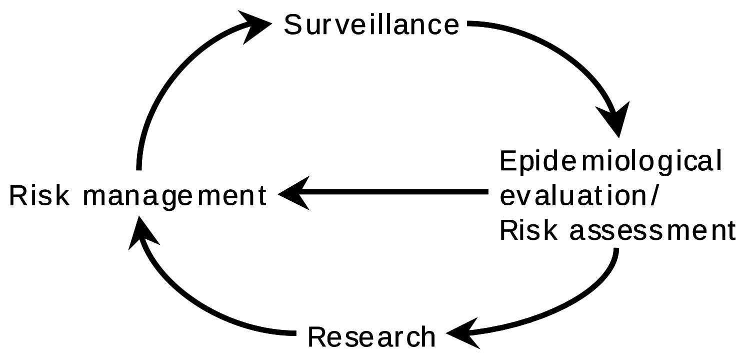


Figure 3. The cycle of public health protection, illustrating the role of surveillance in supporting risk assessment, risk management and formulating new research efforts.

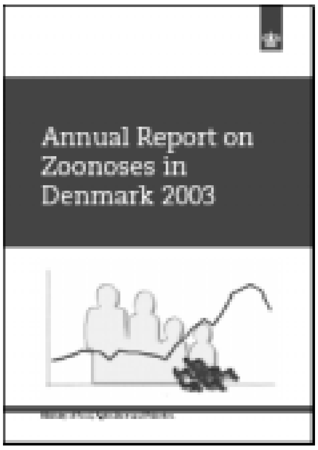
Results from risk assessments provide decision-support to risk managers. The options provided by the risk assessment are evaluated together with social and financial factors (i.e. option assessment). Subsequently, the effect of risk management actions can be monitored through surveillance (i.e. monitoring and review).

SALMONELLA SURVEILLANCE IN DENMARK - AN EXAMPLE OF AN INTEGRATED APPROACH

In Denmark, the successful implementation of a number of surveillance and control programmes can be accredited to the close cooperation between public sector and private industry (Wegener et al., 2003). The authorities have delegated the responsibility for technical coordination of the programmes to committees with representatives from the industry, government bodies and science. In the planning and implementation of programmes, there has been a close involvement of microbiologists and epidemiologists. In addition, there is a very close collaboration between medical and veterinary epidemiologists and microbiologists in monitoring the effect of the programmes on the incidence of human infection.

To initiate and generate the basis for targeted action, The Danish Zoonosis Centre was established in January 1994. The Zoonosis Centre is an epidemiological surveillance and research unit recently moved under the newly formed Ministry of Family and Consumer Affairs (previously the Ministry of Food, Agriculture and Fisheries). The Zoonosis Centre collects all data from all national surveillance and control programmes on zoonoses and conducts an ongoing analysis of the national zoonosis situation from farm-to-fork, including the identification of outbreaks, the assessment of sources of human food borne disease as well as basic epidemiological research.

A report on trends and sources of zoonoses in Denmark is published annually by the Zoonosis Centre (Fig. 4), in hard copy and on the Internet (http://www.dfvf.dk/Default.asp?ID=9606).



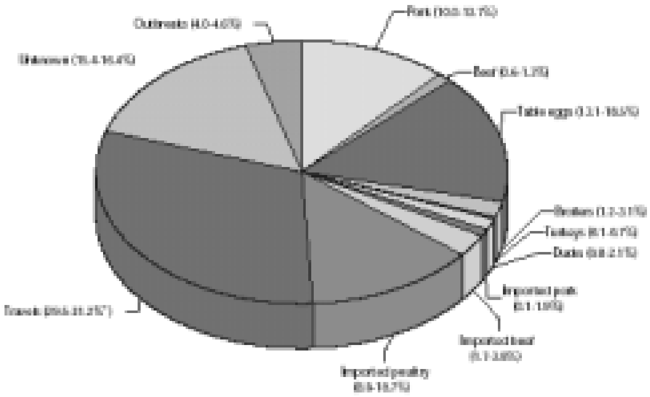


Figure 4. Annual Report on Zoonoses in Denmark with the estimated attribution of major animal reservoirs to human salmonellosis

The report includes an annual account of major sources of food borne salmonellosis based on surveillance, as well as an overview of the trends in the estimated attribution of these sources to human infection since 1988. Detailed knowledge of the distribution of *Salmonella* subtypes in all relevant food animals and food types, generated through intensive and continuous monitoring, is an essential prerequisite for the analysis (Hald et al., 2004).

The Zoonosis Centre conducts quarterly meetings where the current status of the human incidence and control programmes on food borne zoonoses is communicated to relevant stakeholders. The stakeholders are organized in three so-called “coordination-groups”. The first coordination-group also serves as a board for the Zoonosis Centre. It has representatives of all government agencies and institutions involved in monitoring and control of food and water borne infections. This group includes; Statens Serum Institut, the Danish Veterinary and Food Administration, the Danish Plant Directorate, the Danish Institute for Food and Veterinary Research, the National Board of Health, the Danish Environmental Protection Agency and the Royal Veterinary and Agricultural University. The second coordination-group represents the producers; the Danish Bacon and Meat Council, the Danish Meat and Livestock Board, the Danish Dairy Board, the Federation of Egg Producers, the Federation of Slaughter Poultry Producers and the National Board of Agricultural Producers. The third coordination-group consists of "other interested parties", such as the National Consumers Board, the National Retailers Board, the Union of Food Industry Workers, the Danish Industry Board and the Federation of Hotel and

Restaurant Owners. The Centre is also responsible for communication to the general public and the media through press-releases, printed reports, publications, and a website.

A number of other countries have in recent years established similar or related structures to improve surveillance and facilitate communication and coordination. These countries include Finland, Germany, Ireland, Norway, Sweden, United Kingdom, and many more.

FOOD CONTAMINATION MONITORING AT THE NATIONAL LEVEL IN DENMARK

The organization of the Danish food control system has been changed over the last 5 years. Previously, food control at the retail level was carried out by a large number of local food control units that referred to local authorities. Apart from the fact that the local control administration was not cost efficient, the organization was flawed by heterogeneity in several important aspects, such as the evaluation of microbiological results and in prioritizing control activities. Also the decentralized organization of these control units created problems when dealing with nationwide establishments. Re-organization has put the regional laboratories under direct supervision of the national food authority, instead of the local administrations. The control of food production from farm-to–fork was hereby joined in one body, under direct governmental jurisdiction. Furthermore, in the retail sector there has been a movement towards increased own-control in recent years. The implementation of HACCP in the producers´ own-control programmes has reduced the degree of involvement of the authorities in the organization of food control systems.

Currently, the inspection and control is more of an auditing nature with emphasis on generating general knowledge on the contamination on food items, instead of specific knowledge on the general hygiene in establishments, i.e. microbiological testing is focused on collecting data on the occurrence of specific pathogens in various food commodities as compared to earlier where testing for indicator organisms for monitoring of the general hygiene was very common. Thus, the food control in the retail sector is aiming more at collecting information needed to improve human health. Fewer samples are taken on a routine basis, and more samples are taken to gather information on specific problems or to obtain information needed to perform activities within a risk analysis framework (Fig. 3).

Elucidation of specific problems and gathering of information for the use in Risk Analysis are performed in so-called "Centrally coordinated projects". The shift in focus is illustrated by the fact that the number of samples collected for surveillance of general hygiene in retail shops has decreased from 79,000 in 1998 to 23,000 in 2003. In the same period the number of samples collected for specific projects has increased from 3000 in 1998 to 17,000 in 2003.

These projects are carried out to collect information on pathogen/commodity combinations needed in risk analysis. This knowledge may be needed in Risk Assessment (i.e. for gathering data on Exposure Assessment) as well as in Risk Management (i.e. for the Monitoring and Review of the impact of Risk Management options. The centrally co-coordinated projects performed in 2003 are presented in Table 1.

Table 1. Centrally co-coordinated microbiological projects performed in Denmark in 2003, with the number of samples investigated.

Aim	Project	No. of samples
Risk Profiling	Presence of VTEC O26, O103, O111 and O143 in beef cattle	1500
	Presence of Campylobacter in pre-cut ready-to-eat salad	500
Risk Assessment	Effect of different reduction strategies on the number of Campylobacter on broilers at slaughter level	2000
	Presence and number of Campylobacter on turkeys during slaughter combined with antibiotic resistance testing	1500
Risk Management	Surveillance program on antibiotic resistance in bacteria from foods (DANMAP)	1000
	Listeria monocytogenes in ready-to-eat foods	1200
	Vibrio in seafoods (EU control campaign)	1000
	Total	**8700**

The content of these "Centrally coordinated projects" are decided each year through a process involving the central and regional authorities as well as the Danish Institute for Food and Veterinary Research.

CONCLUDING REMARKS

The detection of changes of food borne diseases patterns and variations in the contamination in the food production process are an absolute necessity for the monitoring and continuous improvement of food quality and safety. These programmes need to be sensitive, sensible and cost efficient. Food contamination monitoring and food borne disease surveillance at national level provides a timely and comprehensive overview of the veterinary and public health status of a nation. The integration of food borne disease surveillance has the goal to gather all national surveillance activities in a common public service that carries out many functions using similar structures, processes and personnel. The infrastructure of an established surveillance programme in one area may serve as a framework for strengthening other surveillance activities. Though some food borne diseases may have specific information needs, requiring specialized systems, there may be the potential for synergy and the sharing of common resources.

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