
FOOD SAFETY ISSUES

Surveillance of foodborne diseases: What are the options?

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**FOOD SAFETY UNIT
WORLD HEALTH ORGANIZATION**

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Summary

Surveillance of foodborne diseases: what are the options?

Epidemiological data are needed for a variety of reasons, namely for informing public health authorities about the nature and magnitude of foodborne illnesses and their epidemiology, for the early detection of foodborne disease outbreaks, and for the planning, implementation and evaluation of food safety programmes. Thus, epidemiological surveillance of foodborne diseases is fundamental to any food safety programme.

Various methods of surveillance may be utilized: (i) records for registration of deaths and hospital discharges; (ii) disease notification; (iii) sentinel surveillance; (iv) laboratory surveillance; (v) outbreak investigation; and (vi) epidemiological research.

This document reviews the advantages and disadvantages of each method, and their relevance for meeting the various objectives and needs.

Résumé

Surveillance des maladies d'origine alimentaire : quelles options ?

Les données épidémiologiques sont nécessaires à divers titres : informer les autorités de santé publique de la nature et de l'ampleur des maladies d'origine alimentaire et de leur épidémiologie, détecter dès leur début les flambées de maladies d'origine alimentaire, et planifier, mettre en oeuvre et évaluer les programmes de salubrité des aliments. La surveillance épidémiologique des maladies d'origine alimentaire est donc fondamentale pour tout programme portant sur la salubrité des aliments.

Diverses méthodes de surveillance peuvent être utilisées : (i) les registres des décès et des sorties d'hôpitaux; (ii) les déclarations de cas de maladies; (iii) la surveillance par réseau sentinelle; (iv) la surveillance par les laboratoires; (v) les investigations sur les flambées; (vi) la recherche épidémiologique.

Ce document examine les avantages et les inconvénients de chaque méthode et son intérêt selon les divers objectifs et besoins.

Introduction

Worldwide, diarrhoeal diseases are an important cause of morbidity and mortality (1-6). Food is thought to be a major route of transmission of microorganisms causing diarrhoeal diseases and other diseases such as brucellosis, hepatitis A, listeriosis and botulism (7-21). Food may also lead to disease if it contains toxic chemical substances, either those occurring naturally (e.g. cyanogenic glycosides in cassava), or those resulting from contamination with chemicals (e.g. toxic metals). Many countries have therefore established food safety programmes.

A food safety programme needs information to set priorities, develop policies, monitor progress and evaluate outcomes (9). This information includes: contamination of foodstuffs at different stages of the food chain (production, processing; distribution, storage, preparation practices) and the impact on food safety; food consumption patterns; and occurrence of foodborne diseases and factors leading to them (8, 22). This latter information is obtained through an epidemiological surveillance programme. Thus, epidemiological surveillance of foodborne illness is fundamental to the planning and management of food safety programmes.

In this document, the word "surveillance" refers to the systematic collection and use of epidemiological information for the planning, implementation and assessment of disease control. Surveillance therefore implies "information for action" (23). The objectives of foodborne disease surveillance are to:

- determine the magnitude of the public health problem posed by foodborne diseases, and monitor trends;
- identify outbreaks of foodborne disease at an early stage in order to take timely remedial action;
- determine to what extent food acts as a route of transmission for specific pathogens, and identify high-risk foods, risky food practices and vulnerable populations;
- assess the effectiveness of programmes to improve food safety;
- provide information to enable the formulation of health policies regarding foodborne diseases (including the formulation and prioritization of preventive strategies).

In addition to the above objectives, new developments on the international scene have also underlined the increased need for epidemiological surveillance of foodborne diseases. One is the advent of the Hazard Analysis Critical Control Point (HACCP) system as a method of food safety assurance and the other is the concept of risk assessment and its application to international and national food standards (24).

The HACCP system has proved to be a powerful tool in identifying and assessing hazards in food and establishing necessary control measures (25). Where epidemiological surveillance of foodborne diseases is weak, application of HACCP to food processing and food preparation can be an effective alternative and/or complementary measure for identification faulty or high-risk practices. However, as Fig. 1 illustrates, the hazard identification component of the HACCP system can be greatly strengthened if based on scientific and reliable epidemiological data on foodborne diseases (24).

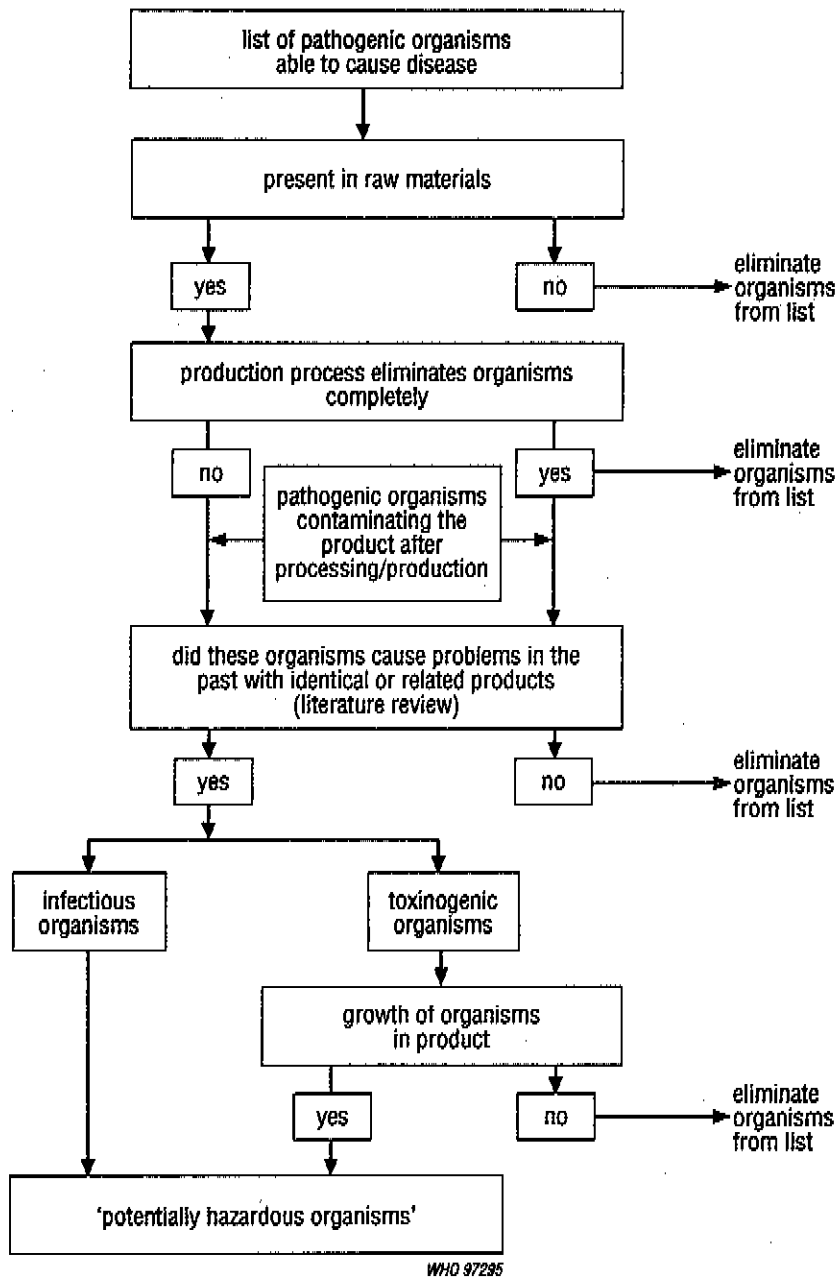


Fig. 1 A decision tree for hazard identification (26)

Risk assessment is defined as a scientifically-based process which involves the following four steps: hazard identification, hazard characterization, exposure assessment and risk characterization. Again, each of these steps necessitate epidemiological data on foodborne illness. The role of epidemiological data in risk assessment is discussed elsewhere (24, 26-28).

In order to achieve the above objectives, various surveillance methods may be employed. Any choice of method will depend partly on the objective under consideration. For instance, one method may be very useful in the early detection of outbreaks but may have severe limitations in estimating the size of the foodborne illness problem.

The following methods for surveillance are discussed in this document:

- records for registration of deaths and hospital discharges;
- disease notification;
- sentinel surveillance;
- laboratory surveillance;
- outbreak investigation.

The objectives of foodborne disease surveillance can sometimes be more effectively and efficiently achieved by using epidemiological studies rather than by carrying out a continuous surveillance programme. Therefore, a section covering methods that go beyond the “normal” methods of surveillance/epidemiological research is also included in this document.

For each of these methods a description is given of the surveillance system, followed by an assessment of its usefulness in relation to the objectives presented in Box 1. The structure of the description of the surveillance system is adapted from that proposed by the United States Centers for Disease Control and Prevention for the evaluation of surveillance systems (23, 29-31).

This document aims to provide managers of national food safety programmes with a description of the strengths and weaknesses of the major tools of foodborne disease surveillance in order to assist them to strengthen existing surveillance activities and possibly to develop additional ones.

The objectives and methods of surveillance of foodborne diseases may vary between countries depending on the availability of resources and the relative importance of foodborne diseases compared with other causes of morbidity and mortality. Suggestions for an approach to selecting surveillance methods are therefore presented in the conclusion.

Registration of deaths and hospital discharge diagnoses

In most countries, physicians complete a death certificate when a person in their care dies. The certificate indicates the cause of death, name, address, sex, date of birth, and date of death of the deceased. In all hospitals in some countries and in some hospitals in others, hospital discharge diagnoses are registered by age and sex of the patient and include other information such as the duration of stay.

The causes of death and hospital discharge diagnoses are usually classified according to the *International Classification of Diseases (ICD)*, which is updated regularly. The most recent update was the Tenth Revision in 1992 (ICD-10) (32)¹.

Population under surveillance

For death certificates, the population under surveillance includes all those whose cause of death is medically certified; the coverage is estimated at 35% (30). For hospital discharge diagnoses, the population under surveillance includes those who may be admitted to a hospital that participates in a discharge diagnosis registration scheme.

Information on death certificates may be analysed centrally by an institution such as a Central Statistical Office. Annual reports may be produced, tabulating the number of people who died from various diseases by age and gender, possibly together with information on denominators (the population at risk). For some diseases, occasional reports may be produced by the central office or by independent investigators. Hospital discharge diagnoses may be analysed locally in the hospital concerned, or nationally.

Utilization of results

Registration of causes of death may in a limited way contribute to estimating the size of the public health problem of foodborne diseases and their trends. Infectious diseases overall have been shown to be an important cause of death in the United States in recent decades (33). Diarrhoeal diseases were a specific problem as a cause of death among the elderly and young children. Although the majority of these cases were classified as presumably non-infectious diarrhoea, a large proportion of these was considered by some authors to have been infectious (34). For conditions which are very likely attributable to foodborne infections, such as non-typhoid salmonellosis (ICD code A02), campylobacteriosis (ICD code A04.5), enteritis due to *Yersinia enterocolitica* (ICD code A04.6) and other bacterial foodborne intoxication (ICD code A05), the number of hospital admissions and deaths is extremely small compared to the total number of cases of foodborne disease estimated from sources such as laboratory surveillance (35).

Other problems also arise. Firstly, diagnosis may be incomplete. For instance, it may be known that the patient had gastroenteritis, but salmonellosis was not diagnosed. In elderly patients with multiple diseases, gastroenteritis may not be recorded on the death certificate at all if other diseases are present. Secondly, the diagnosis may not be specific for foodborne infections. For instance, of all the intestinal infectious cases (ICD codes A00-A09), an unknown and probably variable proportion is acquired through food. Thirdly, although in hospitals the quality of the diagnosis is usually good, patients are selected on the basis of severity of disease and access to hospital, making it difficult to calculate rates (30).

Results can sometimes be used to quantify the occurrence of severe cases of particular infections (36, 37). Hospital-based registries are often used to improve patient care (30, 37), but they may also contribute to disease cost estimates since cases admitted to hospital may be costly compared to those receiving outpatient care alone (36).

¹ In many countries the Ninth Revision (ICD-9) is still in use.

Thus, notification of deaths and registration of hospital discharge diagnoses play a limited role in estimating the public health importance of diseases that may be foodborne and in monitoring trends over time, particularly of the most serious outcomes (Box 1). The usefulness of these systems for surveillance of foodborne diseases is limited since sensitivity is low, except for rare and serious conditions, and attribution to specific foods is uncommon. In countries with other limited surveillance systems for foodborne disease, causes of death tend to be underreported and coverage of hospital care may be incomplete. Countries with comprehensive death registration and universal access to hospitals tend to have more sensitive systems in place for surveillance of foodborne diseases, including notification of selected foodborne illnesses, and sentinel and laboratory surveillance.

Box 1. Methods of foodborne surveillance that are useful in achieving specific objectives

| Specific objective ^a | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|----|-----|----|-----|-----|-----|
| i) Determine magnitude of the public health problem and monitor trends over time | + | ++ | +++ | ++ | + | N/A | +++ |
| ii) Identify outbreaks and take action | + | ++ | + | ++ | +++ | N/A | N/A |
| iii) Identify high-risk foods, high-risk food practices and high-risk populations for specific pathogens | + | + | + | + | +++ | +++ | + |
| iv) Health impact of food safety programmes | + | + | ++ | + | N/A | N/A | ++ |
| v) Information for health policy preventive strategies: formulation and priority-setting (integrating i-iv above) | + | ++ | ++ | ++ | ++ | ++ | ++ |
| Methods: | | | | | | | |
| 1= Registration of deaths and hospital discharge diagnoses | | | | | | | |
| 2= Disease notification | | | | | | | |
| 3= Sentinel surveillance | | | | | | | |
| 4= Laboratory surveillance | | | | | | | |
| 5= Outbreak investigation | | | | | | | |
| 6= Case-control studies of sporadic cases | | | | | | | |
| 7= Population-based surveillance | | | | | | | |
| + to +++ = degree of usefulness for achieving a specific objective (+ = of little use, +++ = best use) | | | | | | | |
| ^a See objectives listed at the beginning of this document. | | | | | | | |

Disease notification

Notification of diseases may be legally required from physicians or other health workers only for selected conditions, and may be optional for others. Information often collected in addition to the diagnosis and date or week of diagnosis includes the age and sex of the patient, and sometimes the name and address and possibly details of clinical symptoms and exposure/risk factors. This information is usually analysed centrally (in the Ministry of Health, for instance, in order to identify national trends) but may be done at regional or district level, particularly for the detection of outbreaks.

Population under surveillance

The population under surveillance includes all persons at risk of conditions which are notifiable or are included in a national reporting scheme who would consult a physician or other qualified health worker for their condition. As the reporting system is passive, underreporting is a common problem (38). The degree of underreporting varies between diseases and countries. In industrialized countries, it is estimated that the incidence of foodborne diseases may be 10–350 times higher than notified cases (39).

Notification requires the physician to diagnose the disease validly (i.e. with reasonable sensitivity and specificity) and reliably (i.e. if repeated by others, there would be similar results). The physician should be aware that the condition is notifiable and should have some incentive to notify, for instance because notification is legally required or because meaningful action can and will be taken. Notification is likely to be more complete if the disease is more serious, is perceived to spread easily from person to person, and if preventive measures are available.

Utilization of results

Reports by medical practitioners may be used to identify outbreaks, as discussed below under outbreak investigation (40). Recently published outbreak investigations that were started by health workers' reports include some on botulism (41), cholera (42, 43) and haemolytic uraemic syndrome or bloody diarrhoea in the presence of *Escherichia coli* O157:H7 infection (44–48). Notifications and reports of disease may also be used to describe the epidemiology of infectious diseases and to monitor trends in disease incidence. Examples are seasonal variation of foodborne intoxication in the United Kingdom (35), and a change in the epidemiology of brucellosis in California from a mainly occupational disease among slaughterhouse workers to a mainly foodborne disease associated with consumption of unpasteurised milk and cheese (49).

The system is extremely useful in detecting serious problems that are relatively rare (cholera, haemolytic uraemic syndrome due to *E. coli* O157), and may be used as an early warning sign leading to outbreak investigation, thereby contributing to understanding of the epidemiology of foodborne diseases (Box 1). The system has limited usefulness for the surveillance of most foodborne diseases since the reported clinical syndromes are often not specific for foodborne disease.

Sentinel surveillance

In sentinel surveillance, selected health events (according to specific case definitions) are monitored by selected health care providers or facilities. For foodborne diseases, relevant health events might include notifiable and non-notifiable syndromes such as diarrhoea, dehydration and haemolytic uraemic syndrome, or specific infections such as campylobacteriosis, salmonellosis or *E. coli* O157:H7 infection (50-53). Laboratory tests may be limited to those requested by the treating physician (54), may include examination of all samples submitted for a range of pathogens (53), or may be performed for all patients attending with a selected condition such as gastroenteritis (51, 52, 55). Reporting may be on a weekly or monthly basis or, if computer systems are used, continuous. Computer systems are used, for instance, in sentinel networks of general practitioners in France for convenience of reporting, early feedback and early detection of outbreaks (54, 56).

Population under surveillance

Although efforts are usually made to select sentinel facilities in such a way that their catchment population is representative of the total population, they may be self-selected or purposely selected, as notification of selected conditions requires extra effort. Motivation of staff at sentinel stations is crucial for the completeness and quality of the data collected (30). The population under surveillance includes people in the catchment area who report to the sentinel facility if they have complaints compatible with foodborne illness. Ideally, the catchment should be clearly defined, although this depends on the organization of the health services in a particular country. If the catchment population is defined, the number of new cases of specified conditions can be translated into consultation rates per 10 000 population (30). Incidence rates of disease are not easily calculated since only a proportion of cases consult a health worker and are diagnosed with the selected condition (52, 54). Consultation rates may be used to calculate trends, although results should be interpreted with care.

Utilization of results

In the Netherlands, sentinel surveillance has been used to determine the consultation rates of salmonellosis and campylobacteriosis with general practitioners (51, 57-59). Of the cases of gastroenteritis presenting to a general practitioner, approximately 5% were attributable to *Salmonella* infection and 15% to *Campylobacter* infection. The overall consultation rates for gastroenteritis varied from 9 to 15 per 1000 practice population per year. In the United Kingdom, sentinel surveillance is part of a set of studies aiming at determining the incidence, agents, risk factors and socioeconomic costs of infectious intestinal disease, a substantial part of which is likely to be foodborne (52). In France, sentinel surveillance led to the identification of an epidemic of gastroenteritis, possible attributable to rotavirus (and probably not foodborne) (56). In the United States, sentinel surveillance was used to determine the consultation rates for *Campylobacter* and *E. coli* O157:H7 infection at health maintenance facilities (50, 53).

The use of sentinel surveillance in developing countries has been difficult since it is a resource-intensive method. However, in countries with well-developed primary health care systems, selected primary health care centres may carry out sentinel surveillance for foodborne diseases.

Consequently, sentinel surveillance may be useful for estimating the public health importance of foodborne diseases and may also play an important role in estimating the impact of food safety programmes, thereby contributing to achieving the first and fourth objectives of foodborne disease surveillance (Box 1). Its usefulness for detection of outbreaks of foodborne diseases is limited unless these occur within one or more of the areas under surveillance.

Laboratory surveillance

Public health and clinical laboratories record results from specimens obtained from patients — most commonly faecal samples from patients with diarrhoea, though other entry criteria may be bloody diarrhoea, bacteraemia or haemolytic uraemic syndrome (42, 47, 60). Pathogens which may be included are *Salmonella typhi*, other *Salmonella* spp, *Campylobacter* spp, *Listeria monocytogenes*, *Vibrio cholerae* and *V. parahaemolyticus*, *Brucella* spp and, more recently, *E. coli* O157 (35, 40, 42, 47, 61-71).

Laboratory surveillance for pathogens such as *Shigella*, rotavirus, small round structured viruses (SRSV), hepatitis A and *Cryptosporidium* has limited value for monitoring the incidence of foodborne diseases as these are frequently transmitted from person to person through direct contact. However, laboratory surveillance for these pathogens may lead to outbreak investigation that implicates food as the route of transmission (35, 39, 40, 72-77).

Population under surveillance

The population covered by laboratory surveillance includes patients attending medical care facilities for whom a laboratory test is requested in those laboratories that participate in the surveillance system. As laboratory participation in surveillance is often on a voluntary basis, the system may not cover all laboratories (50, 64, 67, 68, 78). As laboratories may not all perform the same tests, coverage may be more comprehensive for some agents than for others (65, 67-69, 71, 78). Recording denominators (numbers of patient samples tested) for each pathogen would be very informative but it is not usually carried out routinely (79).

Reporting results

Laboratories record results continuously and may report at intervals (weekly, monthly, quarterly or annually) to a central surveillance centre (64, 65, 70, 80). A high frequency of reporting is particularly important if laboratory surveillance is also used for the detection of outbreaks. For monitoring trends, a low reporting frequency may be adequate. In addition to written reports, some laboratory surveillance systems send patient material or isolates to a central reference laboratory for confirmation, typing or determination of resistance patterns (35, 64, 66-68, 78, 81-83). Ensuring quality and comparability of the data from different laboratories is an important feature of this type of surveillance.

Utilization of results

Results of laboratory surveillance may be used in combination with other data to estimate the magnitude of the public health problem of specific foodborne infections (84). These estimates may be crude as many selection biases are involved, as suggested above. As selection biases may change over time, secular trends need to be interpreted with care. For instance, the increase in the reported incidence of campylobacteriosis observed in the 1980s in many industrialized countries was probably largely due to increased case ascertainment as a result of improved laboratory techniques. On the other hand, because no important changes occurred in the diagnostic or reporting characteristics for salmonellosis in the past two decades, and because selection biases would affect all *Salmonella* serotypes in a similar manner, when *Salmonella enteritidis* became the predominant serotype in western Europe and the United States in the late 1980s and early 1990s the change in reported incidence of this serotype probably reflected an important public health event (35, 80). In animals, *Salmonella enteritidis* was found mainly in poultry and eggs, and a number of outbreak investigations identified eggs as the source of the outbreak. This combined evidence led to the development of various intervention programmes with regard to egg production.

Laboratory surveillance may be used to detect outbreaks of foodborne disease when cases are scattered and symptoms not very specific (47). Recent examples include outbreaks of *E. coli* O157:H7 (85), *Listeria monocytogenes* (86), *Salmonella paratyphi* B (64), *Salmonella enteritidis* (63, 87), *Salmonella javiana* and *Salmonella oranienburg* (88), *Shigella sonnei* (75) and *Vibrio cholerae* (89). Collaboration between European countries in laboratory surveillance of *Salmonella* under the Salm-Net project has been shown to be useful to identify international outbreaks. The network is being renamed 'Enter-Net' as in future it will also cover verocytotoxin-producing *E. coli*.

Although laboratory surveillance data derived from stable surveillance programmes can be used to determine the direction of trends, they are rarely adequate to estimate the magnitude of problems or to attribute observed changes in reported numbers to specific causes. When combined with epidemiological data from other systems, laboratory surveillance improves the overall picture of the public health situation by providing etiological certainty for clinical-based surveillance data.

Thus, laboratory surveillance is valuable in that it makes use of available data to assess the occurrence of specific microbiological agents in sporadic cases and clusters, possibly associated with information on clinical symptoms and on exposure. It is also useful in detecting outbreaks. Its major limitation is selection bias, making interpretation of results complicated and usually requiring complementary sources of information. Laboratory surveillance makes a particularly useful contribution in achieving the first and third objective of foodborne surveillance, namely to monitor trends and identify outbreaks (Box 1).

Outbreak investigation

Outbreak detection

Outbreaks are detected by various means. Health workers, including medical practitioners, may note a shared exposure among self-reporting cases and report the cluster of cases to public health authorities, or they may routinely report selected conditions voluntarily or as required by law (e.g. botulism, cholera, haemolytic uraemic syndrome, bloody diarrhoea, listeriosis) (41, 44, 45, 86, 90-92). Members of the general public or institutions such as schools, universities or places of work may detect an outbreak, for instance after a shared meal at a restaurant, canteen, party, reception, field day or conference (35, 40, 63, 72, 73, 93-100). Outbreaks may be relatively easily detected and investigated if those who have been at risk of exposure are known, e.g. airline or cruise ships passengers (42, 74, 93, 101-103), and populations in institutions such as hospitals, nursing homes and prisons (40, 74, 104, 105). Laboratory surveillance may detect outbreaks, particularly those spread over a region or country (35, 63, 64, 75, 85, 88, 90). An outbreak may be anticipated and investigated after the detection of an increased risk of exposure, for instance by contaminated water (106).

Population under surveillance

The population under surveillance includes those at risk of being involved in outbreaks, provided they are accessible to investigating officers. They are likely to include people attending large functions (weddings, funerals), those eating in restaurants and obtaining food from take-aways or street vendors, and those obtaining pre-cooked or ready-to-eat foods from food industries. Those consuming food prepared at home are usually under-represented in outbreak surveillance as the size of the outbreak is smaller and people are less likely to report it to public health officials (103, 107, 108). For outbreaks detected by laboratory surveillance, selection bias may occur because of limited access to health care and laboratory services, and limited scope of available laboratory facilities, as discussed under the section on laboratory surveillance.

Reporting results

Outbreak investigation is carried out by various disciplines, including public health physicians, epidemiologists, food safety officers, environmental health officers and microbiologists (40, 46, 75, 92, 109, 110). Outbreak investigators should analyse and report as soon as possible to prevent additional cases. National and international compilation of reported outbreaks may be done annually or once every few years for monitoring trends (35, 40, 94, 111, 112).

Methods of outbreak investigation

Investigations may use epidemiological or microbiological methods, or both. In the epidemiological approach a case-control or cohort design may be used. In a case-control study, cases with foodborne disease are compared with controls regarding their food intake, food preparation practices, and other possible risk factors in a given period of exposure. Controls should be representative for the population from which cases were drawn but should not have a foodborne disease in the relevant period of time. The main outcome of a case-control study is an estimate of the relative risk of illness after various exposures. This is estimated by the odds ratio.

Box 2. Two examples of outbreak investigations using a case-control study design

1. An outbreak of cholera from food served on an international aircraft (42)

Case definition: Passengers of an airline flight with diarrhoea within a week after the flight and laboratory evidence of infection with toxigenic *Vibrio cholerae* O1 infection.

Controls: Passengers of the same airline flight without diarrhoea and without evidence of *Vibrio cholerae* O1 infection. Passengers with diarrhoea but without laboratory confirmation of *Vibrio cholerae* O1 infection were excluded from the study.

Data collection method: Face-to-face interview.

Results:

| Consumption of seafood salad | Cases | Controls | Odds ratio |
|------------------------------|-------|----------|-----------------------|
| Yes | 26 | 27 | $(26/4)/(27/48)=11.6$ |
| No | 4 | 48 | |
| Total | 30 | 75 | |

Conclusion: People having eaten seafood salad had an 11-fold increased risk of cholera.

2. *Salmonella enterica* serotype Paratyphi B in goats-milk cheese (64)

Case definition: Residents of France with a positive culture for *S. paratyphi B* between 1 August and 30 November 1993, and symptoms of gastroenteritis or septicaemia.

Controls: For each case, a control was selected from the telephone directory matched for age, sex and city of residence. Those with diarrhoea in the previous three months were excluded.

Data collection method: Telephone interview.

Results:

| | Cases | Controls | Matched odds ratio |
|--------------------|-------|----------|--------------------|
| Brand A | 32 | 10 | 12 |
| Brand unknown | 9 | 8 | 6 |
| Brand other than A | 5 | 10 | 1.7 |
| None | 13 | 30 | 1 (reference) |
| Total | 59 | 58 | |

Conclusion: People having eaten unpasteurized goats-milk cheese brand A had a 12-fold increased risk of illness.

In unmatched case-control studies, the odds ratio is calculated as the ratio of the odds of exposure in cases and the odds of exposure in controls. In matched case-control studies, the odds ratio is calculated as the number of exposed cases with non-exposed controls divided by the number of exposed controls with unexposed cases. In the recent literature, there are many examples of a case-control design (42, 45, 46, 63, 64, 75, 76, 88, 90, 92, 95, 98, 101, 104, 113). Two examples are given in Box 2. A more elaborate description of case-control studies is given in basic textbooks on epidemiology (e.g. 114). The application of case-control studies in diarrhoeal diseases is described by Cousens et al (115). Schlesselman and Breslow & Day present advanced discussions of methodological issues (116, 117).

A cohort study compares attack rates of an illness in those who have eaten certain food items and those who have not. The ratio of these two attack rates is expressed as a relative risk. Cohort studies are used somewhat less often than case-control studies but may be a convenient and powerful tool if those at risk are easily listed, such as passengers on a cruise or guests at a party (72, 73, 86, 96, 99, 100, 102-104, 113, 118). Its advantage over a case-control study is that absolute risks (attack rates) can be obtained. An example is given in Box 3.

Box 3. Example of outbreak investigations using a cohort study design

A large outbreak of gastroenteritis caused by diarrhoeal toxin-producing *Bacillus cereus* (96).

Cohort:

Those attending a university field day.

Case definition:

Diarrhoea (three or more loose stools in a 24-hour period) within five days after the field day.

Data collection method: Postal questionnaire.

Results:

| Consumption of pork | Total | Number of cases | Attack rate | Relative risk |
|---------------------|-------|-----------------|-------------|---------------|
| Yes | 523 | 137 | 26% | 5.4 (1.4-21) |
| No | 41 | 2 | 5% | |

Conclusion: Of people having eaten barbecued pork, 26% became ill. Those eating pork were five times more likely to become ill than those not eating pork.

When microbiological (including parasitological) methods can be employed, the pathogen causing the outbreak may be identified in the patients (42, 44, 46, 63, 64, 72, 73, 75, 85, 86, 88, 91, 95, 101, 103, 104, 110, 118), in the suspected food (44, 46, 63, 64, 72, 85, 88, 92, 96, 118), or in both. Microbiological evidence is strongest if the etiological agent is characterized as specifically as possible, for instance through serotyping, phage typing, plasmid analysis, determining the pattern of antimicrobial resistance, or by using new molecular typing methods (35, 40, 41, 63-65, 75, 92, 94, 95, 99, 101, 104, 119-122).

The strongest causal evidence is obtained if both epidemiological and microbiological evidence is obtained (46, 64, 72, 88, 118). However, this is not always feasible for a variety of reasons. Epidemiological evidence may be difficult or impossible to obtain because epidemiological skills are not available, because the outbreak was detected too late for a successful epidemiological investigation, or because it was too small to obtain statistically significant results. Microbiological evidence may be unavailable because food samples were not available, or because the pathogen cannot be demonstrated easily in patients — e.g. toxin of *B. cereus* or *S. aureus* (119, 123), or short period of excretion of the pathogen, or late contacting of patients— or because of laboratory limitations. For instance, small round structured viruses (SRSV, or Norwalk agent) cannot be identified in most laboratories and have therefore been underestimated as causes of outbreaks of foodborne illness (74, 124-126).

Utilization of results

Results of an outbreak investigation should be utilized immediately as the basis for taking rational measures to control the outbreak itself, such as withdrawal of the implicated product or adjustment of the production process. Results may find a wider application if the identification of high-risk foods or high-risk food practices is used for the prevention of further outbreaks (35, 40, 46, 50, 72, 73, 76, 77, 87, 88, 90, 94, 96-98, 100-104, 110, 113-118, 124, 127-129). Publication of results is therefore very useful for health policy-makers and for the producers, distributors, preparers and consumers of the food concerned. Outbreak investigation may also contribute to knowledge of the symptoms, dose-response relationships, and incubation period of the infection concerned and contribute to risk assessment (76, 93, 98, 119, 130, 131). Some examples of recently published results from outbreak investigations of foodborne diseases are given in Table 1.

For monitoring the incidence of foodborne illnesses over time, or making comparisons between countries, data from outbreak investigations have severe limitations, mainly because sporadic cases are not included. In addition, selection biases in the detection and investigation of outbreaks are likely to be strong and may be subject to differences in time, place and groups of persons (103, 111).

Outbreak investigation is useful in that it responds to public demand and can provide timely information to prevent further cases of foodborne disease. It may also be a unique source of information on routes of transmission of specific pathogens and for the identification of high-risk environments and high-risk food-handling practices. Its major limitations are the high resource requirements in terms of skilled manpower and laboratory facilities, and a strong selection bias towards large or serious outbreaks and against small clusters and mild disease. Outbreak investigation is particularly useful in achieving the second and third objectives of surveillance of foodborne diseases: *take remedial action to limit the size of outbreaks, determine to what extent food acts as transmission routes of specific pathogens, and identify high risk foods and food handling practices and high risk populations* (Box 1).

Table 1. Examples of recently published results from outbreak investigations of foodborne diseases

| Microbiological agent | Food implicated | Factors contributing to outbreak | Action taken | Reference |
|---|--|---|---|-----------|
| <i>Bacillus cereus</i> | Fried rice | Keeping cooked rice at room temperature | Education of day care staff | 118 |
| <i>Cryptosporidium</i> | Apple cider | Apples harvested from pastures where cattle grazed, insufficient washing of apples before use | Guidelines for cider production | 72 |
| <i>Escherichia coli</i> O157:H7 | Hamburgers in chain of fast-food restaurants | Errors in meat processing and cooking | Recall of hamburgers | 47 |
| <i>Salmonella enterica</i> serotype paratyphi B | Goats-milk cheese | Use of unpasteurised milk; insufficient microbiological monitoring of milk and cheese | Recommendations on cheese production and education of public | 64 |
| <i>Salmonella typhimurium</i> | Roast pork | Keeping meat unrefrigerated; reheating briefly in microwave | Recommendations on health education | 113 |
| <i>Shigella sonnei</i> | Iceberg lettuce | Faecal contamination of lettuce | Withdrawal of lettuce, support for restriction, public health warning | 75 |
| <i>Vibrio cholerae</i> | Various street-vended foods | Food preparation (contaminated raw products and water, cross-contamination, time-temperature abuse) | Recommendations on licensing street vendors and health education | 135, 136 |

Beyond surveillance: epidemiological surveillance

The objectives of foodborne disease surveillance can sometimes be achieved more completely or more efficiently by epidemiological studies than by a continuous surveillance programme. Categories of such epidemiological studies are discussed below, with recent examples of how they may contribute to achieving the objectives of surveillance of foodborne diseases. A distinction is made between epidemiological studies based on health facilities and those based on population.

Studies based on health care facilities

Case reports

Reports on individual cases or case series may be used to generate hypotheses on associations between exposure and disease. Recent examples include the suggestion that *Cyclospora cayetanensis* infection may be foodborne, based on a case report (132), and a description of bacterial pathogens, in particular *E. coli* O157 among patients with haemolytic uraemic syndrome (133). In the absence of control groups, associations may be suggested by biological plausibility in individual cases or a high prevalence of exposure in case series, although they cannot be determined epidemiologically.

Case-control studies of sporadic cases

Case-control studies based on health care facilities may be particularly suitable to determine the extent to which disease can be attributed to specific pathogens and which foods act as a route of transmission for specific pathogens, as well as to identify high-risk foods and high-risk food practices. For instance, in Thailand pathogens associated with diarrhoeal disease in children were determined in a hospital-based case-control study (134). In Ecuador, Guatemala, Peru and the Philippines hospital-based case-control studies on cholera showed that foodborne transmission occurred through street vendors (89, 135-137). Other examples include a hospital-based case-control study in Thailand on risk factors for *Vibrio cholerae* O139 infection (138) and a health centre-based case-control study on diarrhoeal diseases in Malaysia (139).

Similarly, cases detected through laboratory surveillance may be enrolled in a case-control study to identify high-risk foods and high-risk food practices, especially for sporadic cases. Examples are case-control studies on *Campylobacter* (107, 140), *E. coli* O157:H7 (65), *Listeria monocytogenes* (141), *Salmonella enteritidis* (142), *Salmonella javiana* and *oranienburg* (88), and *Yersinia enterocolitica* (143), which resulted in the identification of high-risk foods for acquiring these infections.

Population-based studies

When Snyder & Merson attempted to estimate the magnitude of the global problem of diarrhoeal diseases, they decided to base these estimates on the most valid data obtained from longitudinal, prospective, community-based studies of stable populations with low migration rates (144). Similarly, such studies would also provide the most valid estimates of many foodborne diseases as they can be used not only to estimate the incidence rates of diarrhoeal diseases, but also to identify pathogens and risk factors. However, these studies have a number of methodological problems such as the definition of an episode of diarrhoea and the optimal intensity of follow-up (145). Bern et al. suggested in their update of the study by Snyder & Merson that the incidence rates of diarrhoeal diseases reported increased with an increasing frequency or intensity of surveillance. The case definition used had no apparent pattern of effect on the incidence rates (146).

Longitudinal population-based studies can determine the incidence rate of diarrhoeal diseases in well-defined populations. Provided the incidence is sufficiently large (depending on the incidence rate, the size of the study population, and the duration of follow-up) risk factors may be determined as well. These epidemiological studies require extensive resources and need to be carefully planned. Some of the issues needing consideration are selection of the study population (age groups, geographical areas), duration of the study (seasonality of specific infections), data collection methods (e.g. home visits, self-administered questionnaires, telephone interviews), laboratory requirements (possible laboratory investigations of all cases, or of a control group without complaints), frequency of follow-up, case-definition, and plan of analysis (how to attribute cases to foodborne transmission). For foodborne diseases other than diarrhoeal diseases, the incidence rate may be too low for a population-based incidence study to be feasible. For such diseases, other methods of estimating incidence need to be used (e.g. laboratory surveillance, disease notification).

As population-based longitudinal studies provide the most valid estimates of the incidence rates of foodborne diseases, they may be used to estimate the sensitivity of other surveillance systems in detecting cases of foodborne illness. For instance, in a population-based study in the Netherlands, the incidence rate of gastroenteritis was estimated at 45 per 100 person-years; 4.5% and 1.5% were attributable to *Campylobacter* and *Salmonella* infection respectively (147). This would correspond to an estimated 300 000 cases of campylobacteriosis and 100 000 of salmonellosis in the Netherlands (population 15.2 million). On the basis of sentinel surveillance, it was estimated that each year approximately 17 000 cases of campylobacteriosis and 5000 cases of salmonellosis are seen in general practice. In laboratory surveillance some 3000 cases of salmonellosis and 4000 cases of campylobacteriosis are found annually. Finally, in outbreak investigations carried out by the Food Inspection Services in the period 1991-1994, 18 people were found in outbreaks attributed to *Campylobacter* and 290 in outbreaks attributed to *Salmonella* (108) (see Figs. 2a & 2b). Similarly, in the United Kingdom longitudinal population-based studies have been carried out, in combination with sentinel surveillance and general practice-based case-control studies (52).

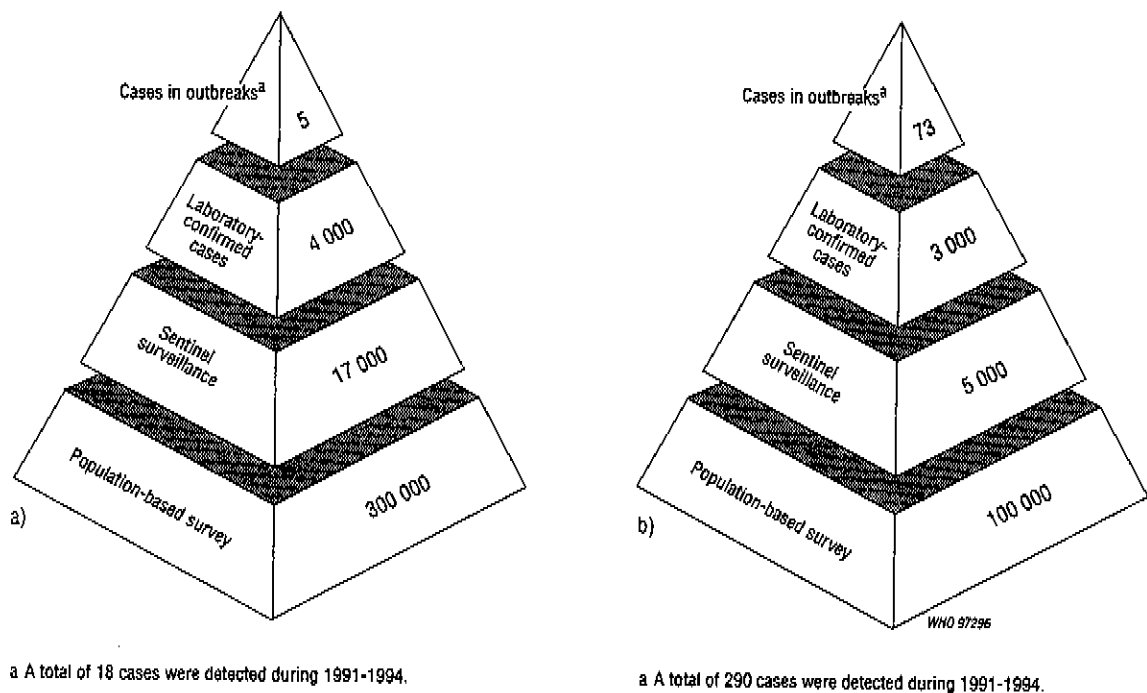


Fig. 2 Annual incidence of a) campylobacteriosis and b) salmonellosis in The Netherlands according to different systems of surveillance (adapted from P. Sockett, Ph.D thesis)

Conclusion

Managers of food safety programmes need information to advocate for food safety issues and for decision-making in food safety programmes. In reviewing information needs, it may be helpful to review the objectives of surveillance of foodborne diseases and determine which surveillance systems are best suited to provide the required information (Box 1). Once a decision is made on the type of information required, a review of available information should be made. Obviously, information which is available from routine data collection (and probably collected for other purposes as well) is the least costly to obtain.

If it is decided that the available information is insufficient, additional surveillance activities may be needed. As additional data collection requires additional resources, this decision is likely to involve a process of prioritization: how important is surveillance of foodborne diseases compared with other surveillance or other public health activities? An example of criteria that may be used in priority-setting for surveillance are presented by Teutsch. In general, surveillance should be established only if the information obtained may be expected to be used for control measures (148). It may be helpful to decide who should act on the information— local authorities or national ones? The surveillance system should be designed in such a way that it reaches those who need to take action in time.

Whatever options are chosen, no single system is likely to provide all the required information, or to provide perfect information. Rather, the following statement on surveillance in general also applies to surveillance of foodborne diseases:

“Since no one source is usually adequate, good public health decision-making requires the synthesis of data of varying quality from a wide range of sources as well as the critical interpretation of findings” (30).

Acknowledgements

The authors would like to acknowledge with thanks the contribution of the following persons in reviewing this document: Ilse van Asperen, Arie Havelaar, Matty de Wit (National Institute of Public Health and Environmental Protection, Bilthoven, Netherlands); Jocelyn Rocourt (Pasteur Institute, Paris, France); Morris Potter (Centers for Disease Control, Atlanta, GA, United States of America); Michel Thuriaux, Guénaél Rodier (Disease Surveillance and Control Unit of the Division of Emerging and other Communicable Diseases Surveillance and Control, WHO, Geneva, Switzerland); Anthony Hazzard (WHO Collaborating Centre for Environmental Health, Sydney, Australia).

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Annex I

Attributes of various surveillance systems

Registration of deaths and hospital discharge diagnoses

Simplicity: The systems are simple as they are applied routinely and reporting is usually a single step from the medical practitioner to the central institute dealing with vital statistics for death registration, or from the hospital to a central office for hospital-based registries. The information on the cause of death may not be easy to interpret; determining the cause of death may not be straightforward and information on route of transmission is usually not available. Foodborne transmission can at best be implied both for notifications of cause of death and for data from hospital registries.

Flexibility: Limited. The method may be applied to a range of diseases, but adapting the system of data collection is hardly feasible.

Acceptability: Acceptability is high provided there is no breach of confidentiality towards patients.

Sensitivity: Sensitivity for the detection of foodborne illnesses is generally very limited as most of these do not lead to death or hospital admission. Sensitivity may be further limited depending on the proportion of deceased seen by a physician after death and the accessibility of hospitals.

Positive predictive value: Attributing disease or death to foodborne transmission requires additional information from analytical epidemiological studies.

Representativeness: For death notification this depends on the proportion of deceased seen by a physician after death and for hospital registries this depends on the proportion of hospitals participating in the registration of discharge diagnoses. If these proportions are high, representativeness is also high for cases serious enough to lead to hospital admission or death.

Timeliness: For both systems there is often a long delay until data have been processed and analysed. Direct action needed for outbreak investigation would depend on the physician notifying death or treating the patient in hospital taking action outside these routine systems.

Resources required: Additional resources needed for surveillance of foodborne illness are very limited as the systems are in place for other purposes.

Disease notification

Simplicity: The system is simple and usually in place.

Flexibility: Changes in the conditions to be notified can be made fairly easily, although there are limitations on the amount of change practitioners can cope with.

Acceptability: Acceptable to physicians and patients. For physicians important criteria for acceptability are that conditions included are relatively rare and are seen to be of public health importance (i.e. they are serious and interventions are available to prevent their spreading). Feedback of results to the physicians and health workers (if possible including not only the number of notified cases but also action taken on the basis of these numbers) is very important to keep them informed and motivated. For patients, notification would also be generally acceptable, particularly if it leads to preventive action and provided that confidentiality is maintained as far as is possible.

Sensitivity: The proportion of cases included in the system depends on the proportion of patients seen by a physician, the quality of diagnosis of the physician, and the willingness of physicians to notify (29). Sensitivity is expected to be high if health care services reach most of the population and the condition under surveillance is serious and well recognized (e.g. botulism in developed countries). Sensitivity may be low if there are many asymptomatic cases (e.g. hepatitis B or cholera), or if the disease is not a clear clinical entity (e.g. food intoxication). If laboratory results are required for a notification, direct reporting by laboratories may have a larger sensitivity than reports by physicians (38).

Positive predictive value: The proportion of notified patients actually having the relevant disease increases with an increased specificity of the diagnosis and increased prevalence of the disease (23, 29). This specificity is fairly good for most infections if laboratory confirmation can be obtained. If transmission by food is included in the case definition, the positive predictive value also depends on the specificity of exposure data and the importance of food as a route of transmission for the infection.

Representativeness: Representativeness is increased with increased coverage of the health care system. Coverage is likely to be more complete for serious conditions (e.g. haemolytic uraemic syndrome) than for mild ones (e.g. watery diarrhoea).

Timeliness: This depends very much on the administrative set-up. It is usually quickest at local level (identification of outbreaks) and much more slow at national level (monitoring secular trends).

Resources required: Resources needed to operate the system are limited. Follow-up of notifications and feedback to those notifying are very important in keeping the system working.

Sentinel surveillance

Simplicity: Establishment of a sentinel surveillance system is a major effort.

Flexibility: Within a sentinel system it is rather easy to change diseases or conditions on which practices should report.

Acceptability: Acceptability to the health providers is crucial for sentinel surveillance to work. This is one reason why the selection of participating practices is usually not random. To the population the system is acceptable. If people know that some providers have a particular interest in particular conditions they might even consult these providers preferentially when they have these conditions. This may lead to overestimating the occurrence of those conditions.

Sensitivity: The system is sensitive in detecting sporadic cases of foodborne diseases as long as they report to the health provider. The sensitivity in detecting outbreaks of foodborne disease is limited as only a small proportion of the population is covered (e.g. around 1% of the total population in Belgium, France, the Netherlands and the United Kingdom) (30).

Positive predictive value: The proportion of notified patients actually having the relevant disease increases with an increased specificity of the diagnosis and increased prevalence of the disease (23, 29). This specificity may be good in sentinel practices as it may be possible to obtain laboratory confirmation. If transmission by food is included in the case definition, the positive predictive value also depends on the specificity of food consumption data and the importance of food as a route of transmission for the infection.

Representativeness: Representativeness partly depends on the selection of practices, but also on how well the system works in including all eligible patients. It is important to assess whether participation of a practice or clinic in a sentinel network changes patients' health-seeking behaviour.

Timeliness: Sentinel surveillance is able to provide timely data.

Resources required: Many resources are needed, including motivated health care providers; if etiological agents are to be identified, adequate laboratory facilities; means of communication feedback within the network both for reporting and for providing feedback; education/training of participants; and perhaps financial incentives for participants.

Laboratory surveillance

Simplicity: When laboratory services are available, collecting information on results obtained is simple.

Flexibility: The system is flexible with regard to the choice of infections included.

Acceptability: Acceptability is high provided there is no breach of confidentiality towards patients.

Sensitivity: The system has limited sensitivity as only a small proportion of patients may reach a medical care facility and a laboratory test may be requested for only a small proportion of these.

Positive predictive value: Provided the etiological agents monitored are mainly transmitted by food, the positive predictive value is expected to be high, as most patients included have symptoms compatible with a clinical diagnosis of foodborne disease.

Representativeness: Patient selection bias is strong; included are those who have access to medical care and are using it. In addition, requests for laboratory tests depend on the health worker/physician and current standards of medical care.

Timeliness: This depends on the frequency of reporting: the higher the frequency of reporting, the more likely that data will also be useful in identifying outbreaks.

Resources required: Laboratory services demand many resources (skilled personnel, equipment, media, reagents). Once laboratory services are available (and usually financed in the context of patient care), the additional cost of laboratory surveillance is limited to administrative costs and possibly a quality assurance system.

Outbreak investigation

Simplicity: Outbreak investigation is not very simple as it requires epidemiological skills and access to microbiological laboratory services. Compilation of reports on outbreak investigations is made easier if simple, standard report forms are introduced. Examples of these are given in Annex 2. Other examples can be found in other documents (150-153).

Flexibility: Outbreak investigation is flexible: similar methods of investigation can be applied to a range of problems.

Acceptability: Outbreak investigation is likely to be demanded by the public or policy-makers if the occurrence of an outbreak is noticed.

Sensitivity: Only a small proportion of foodborne disease occurs in the form of outbreaks. This surveillance method will fail to identify sporadic cases of foodborne disease which form the major part of the problem. Sensitivity is likely to vary by perceived severity and by etiologic agent: it may be high for botulism, but low for salmonellosis, campylobacteriosis or other diarrhoeal diseases (51, 107, 108).

Positive predictive value: Of all reported outbreaks of foodborne disease, how many are actually foodborne? As suggested above, the more complete the information collected, both epidemiologically and microbiologically, the higher the positive predictive value.

Representativeness: This is likely to vary and needs to be assessed carefully. Does the system cover mainly urban populations? How large or serious does an outbreak need to be to be investigated? As suggested above, outbreak investigation cannot give representative data on all foodborne diseases since sporadic cases are excluded.

Timeliness: Outbreak investigation should provide timely information for preventing additional cases.

Resources required: These include personnel skilled in field epidemiology and outbreak investigation, and access to microbiological laboratory facilities. Interviewers and health/food inspectors, together with transport, need to be available at short notice.

Annex 2

**Example of an outbreak report form used by the WHO Surveillance Programme for
Control of Foodborne Infections and Intoxications in Europe (112)**

| REPORT OF INCIDENT | | | | |
|--|---|---|------------------------------------|-------------------|
| 1. COUNTRY : | 2. YEAR : 19 <input type="checkbox"/> <input type="checkbox"/> | 3. REPORT NO.: <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | | |
| 4. Place of incident : | | | | |
| City/Town : _____ | | Province/District : _____ | | |
| 5. Causative agent/type: | | | | |
| Code : <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> _____ | | | | |
| Phagetype : <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | | Confirmed: <input type="checkbox"/> | Presumed: <input type="checkbox"/> | |
| 6. Number of persons: | | | | |
| at risk: _____ | | ill : _____ | hospitalized : _____ | died : _____ |
| by age groups | | | | |
| from 0 to 4 : | | _____ | _____ | _____ |
| from 4 to 15 : | | _____ | _____ | _____ |
| from 15 to 60 : | | _____ | _____ | _____ |
| over 60: | | _____ | _____ | _____ |
| 7. Symptoms | | | | |
| nausea: _____ | | vomiting: _____ | diarrhoea: _____ | abdom.pain: _____ |
| fever: _____ | | neurolog.: _____ | cardiovas.: _____ | other: _____ |
| 8. Date of onset of illness : (day/month/year) | | | | |
| first person : <input type="checkbox"/> <input type="checkbox"/> / <input type="checkbox"/> <input type="checkbox"/> / <input type="checkbox"/> <input type="checkbox"/> | | last person : <input type="checkbox"/> <input type="checkbox"/> / <input type="checkbox"/> <input type="checkbox"/> / <input type="checkbox"/> <input type="checkbox"/> | | |
| 9. Incubation time and duration of illness: (in hours H/days D) : <input type="checkbox"/> ? | | | | |
| Incubation time: | | shortest: _____ | longest: _____ | median: _____ |
| Duration of illness: | | shortest: _____ | longest: _____ | median: _____ |

10. Food/Vehicle involved :Code -----Confirmation : Laboratory: Epidemiological:

Commercial name of product: -----

Producer : -----

11. Methods of marketing, processing, serving :Marketed: Code Treatment before final preparation : Code Served and eaten : Code **12. Place where food was contaminated :**Place: Code Country: Code **13. Place and date where food was acquired and eaten :**Date : / / Place : Code

During transit :

means of transit : Code from: Code to Code **14. Factors contributing to incident:**a) Code b) Code

other : -----

Note: -----
In case of more than one factor may have contributed, list all that are applicable,
but code the two major ones only**15. Results of lab tests :** testing laboratory : -----

| Specimens/samples | Number tested | positive | Details/comments |
|--------------------|---------------|----------|------------------|
| Ill people ° | ----- | ----- | ----- |
| Well people ° | ----- | ----- | ----- |
| Food handlers | ----- | ----- | ----- |
| Suspect. food | ----- | ----- | ----- |
| Other foods | ----- | ----- | ----- |
| Environment | ----- | ----- | ----- |

° clinical samples

**Example of an outbreak report form used in England and Wales for investigation of
general outbreaks of infectious intestinal disease (149)**

OUTBREAK NO 97\.....

Name: _____ Address: _____
 Position: _____
 Telephone: _____ LA: _____ DHA: _____
 Date: _____

1) **MODE OF TRANSMISSION (tick one only)**

Mainly person to person Mainly foodborne
 Equal or unknown proportion of foodborne and person to person
 Other Specify water, animal contact etc _____ Unknown

2) **PLACE WHERE OUTBREAK OCCURRED, or if foodborne where food was prepared or served. Tick one only.**
 If foodborne, "PREPARED" takes precedence over "SERVED" eg. If food was prepared in a shop, but served in a house, tick "Shop/Retailer", if food was prepared at a house and served elsewhere, tick "Private House".

- a) Private House
- b) Hotel\Guest House\Residential Pub Specify _____
- c) Restaurant\Cafe Specify ethnicity _____
- d) Pub\Bar
- e) Mobile Retailer Specify market trader, chip van etc _____
- f) Armed Services Camp Specify army, navy etc _____
- g) Canteen Specify work, college _____
- h) Shop\Retailer Specify bakers, butchers etc _____
- i) Hospital Specify general, geriatric, EMI _____
- j) Residential Institution Specify nursing\residential home _____
- k) School Specify nursery\junior etc _____
- l) Other Specify _____

3) **NAME AND ADDRESS OF PLACE:** _____

 _____ Postcode (if known) _____

4) **WAS THE OUTBREAK AT A FUNCTION** YES NO Date of function/...../.....

5) **WAS PATHOGEN/TOXIN identified?** YES NO

If YES give Organism/Toxin _____ Serotype _____ Phage Type _____

If NO Specify organism suspected _____

6) **LABORATORY where tests performed:** State first and reference labs, even if microbiology was negative

_____ _____
 First lab Reference lab

- 7) **TOTAL NUMBER AFFECTED** (diarrhoea and/or vomiting +/- any other symptoms) _____
TOTAL NUMBER AT RISK _____ Number admitted to hospital _____ Number known to have died _____

8) **LABORATORY RESULTS**

| NUMBER OF PEOPLE | AFFECTED PEOPLE | | WELL PEOPLE | |
|--|-----------------|----------|-------------|----------|
| | TESTED | POSITIVE | TESTED | POSITIVE |
| 8a. HOSPITAL OR RESIDENTIAL OUTBREAKS <i>ONLY categories i) and j) in question 3</i> | | | | |
| Residents/Patients | | | | |
| Staff | | | | |
| Total | | | | |
| 8b. ALL OTHER OUTBREAKS | | | | |
| Non food handlers | | | | |
| Food Handlers | | | | |
| Total | | | | |

- 9) **DATE OF ONSET:** First known/...../..... Last known/...../.....

- 10) **SUSPECT FOOD VEHICLE ASSOCIATED WITH ILLNESS:** only list specific vehicles for which there is a microbiological, statistical or other convincing association with illness.

| VEHICLE | EVIDENCE (TICK) | | |
|---------|------------------|-------------------------|--------------------|
| | Microbiological | Statistical Association | |
| | Vehicle positive | Cohort Study | Case Control Study |
| | | | |
| | | | |
| | | | |

Please give other evidence implicating food stuff if available (i.e strong circumstantial evidence) _____

11) **FAULTS THOUGHT TO HAVE CONTRIBUTED TO OUTBREAK:**

- Infected food handler Give details: _____
- Inadequate heat treatment Give details: _____
- Cross contamination Give details: _____
- Storage too long/too warm Give details: _____
- Other Give details: _____

Environmental Health Department's inspection rating of premises (if available) (A - F)

- 12) Please enclose or forward full report if available. Append details of microbiology, statistical and other evidence

**Example of a draft report form used by the World Health Organization
for collection of data on foodborne disease outbreaks**

[the form has been based on different documents (112, 149-153) and is presently being tested]

| REPORT OF INCIDENT | | | | |
|--|--|---|--------------|-------|
| 1. COUNTRY: <input type="checkbox"/> <input type="checkbox"/> | 2. CONTINENT: <input type="checkbox"/> <input type="checkbox"/> | 3. YEAR: <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | | |
| 4. Place of incident: | | | | |
| City/Town: _____ | | Province/District: _____ | | |
| 5. Investigator: | | | | |
| 6. Causative agent/type: | | | | |
| Code: <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> _____ | | | | |
| Page type (according to report): <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Confirmed (N/Y): <input type="checkbox"/> Presumed (N/Y): <input type="checkbox"/> | | | | |
| 7a. Number of persons: | | | | |
| At risk: _____ Ill: _____ No. confirmed: _____ Hospitalized: _____ Died: _____ | | | | |
| Age range: _____ Mean/Median age _____ | | | | |
| <i>By age groups</i> | At risk | Ill | Hospitalized | Died |
| Foetus | _____ | _____ | _____ | _____ |
| <1 year | _____ | _____ | _____ | _____ |
| 1-5 years | _____ | _____ | _____ | _____ |
| 6-15 years | _____ | _____ | _____ | _____ |
| 16-19 years | _____ | _____ | _____ | _____ |
| 20-29 years | _____ | _____ | _____ | _____ |
| 30-39 years | _____ | _____ | _____ | _____ |
| 40-49 years | _____ | _____ | _____ | _____ |
| 50-59 years | _____ | _____ | _____ | _____ |
| ≥60 years | _____ | _____ | _____ | _____ |
| 7b. Sex distribution (state number): Male: _____ Female: _____ | | | | |

8. Specific conditions/Health status (state number and specify where applicable):

- Pregnant _____ -Cancer _____
 -Malnourished _____ -Immunosuppressive therapy _____
 -Liver disease _____ -Antacid treatment _____
 -Diabetes _____ -Allergy (specify) _____
 -AIDS (D/I) _____ -Under Medication (specify) _____
- _____
- Other previous health problem (eg. history of infection/other disease)
- _____

9. Signs & symptoms (check appropriate box and state the number (percentage) of patients with any given symptom):

Intoxications

- Nausea _____
 Vomiting _____
 Anaemia _____
 Bloating _____
 Burning sensation (mouth) _____
 Cyanosis _____
 Dehydration _____
 Excessive salivation _____
 Flushing _____
 Foot/wrist drop _____
 Insomnia _____
 Metallic taste _____
- Pallor _____
 Pigmentation _____
 Prostration _____
 Scaling of skin _____
 Thirst _____
 Weight loss _____
 White bands on fingernails _____
 Others (specify) _____

Enteric infections

- Abdominal pain _____
 Diarrhoea _____
 bloody _____
 greasy _____
 mucoid _____
 watery _____
 No./day _____
 Chills _____
 Constipation _____
 Fever _____
 Tenesmus _____

Generalized infections

- Cough _____
 Edema _____
 Headache _____
 Jaundice _____
 Lack of appetite _____
 Malaise _____
 Muscular aching _____
 Perspiration _____
 Stiff neck/joints _____
 Swollen lymph nodes _____
 Weakness _____
 Others (specify) _____

Localized infections

- Ear _____
 Eye _____
 Itching _____
 Mouth _____
 Rash _____
 Skin lesion _____
 Describe: _____

 Others (specify) _____

Neurological illness

- Blurred vision _____
 Coma _____
 Delirium _____
 Difficulty in speaking _____
 Difficulty in swallowing _____
 Dizziness _____
 Double vision _____
 Irritability _____
 Numbness _____
 Paralysis _____
 Pupils: dilated, fixed
 or constricted
 Tingling _____

Specific signs: Miscarriage _____ Birth Defects _____

10. Date of outbreak/onset of illness (day/month/year):First person: /Last person: /**11. Incubation time and duration of illness: (in hours H / in days D) :**

Incubation time: Shortest _____ Longest _____ Median/Mean _____

Duration of illness: Shortest _____ Longest _____ Median/Mean _____

12. Food/Vehicle involved :Code _____Confirmation: Laboratory (N/Y): Epidemiological (N/Y):

Commercial name of product: _____

13. Type of processing/preparation: Code **14. Place where food was contaminated:**Place: Code

Country: _____

15. Date and place where incriminated food was consumed:Date: a) /b) /Place: Code Imported (N/Y): Means of transit: Code

Country: From: _____

To: _____

16a. Factors related to contamination of food:a) Code b) Code

Other: _____

Note: In case more than one factor may have contributed, list all that are applicable, but code the two major ones only

16b. Factors related to microbial survival:a) Code b) Code

Other: _____

Note: In case more than one factor may have contributed, list all that are applicable, but code the two major ones only

16c. Factors related to microbial growth:a) Code b) Code

Other: _____

Note: In case more than one factor may have contributed, list all that are applicable, but code the two major ones only

17. Time and temperature between preparation and consumption:

Time (H): _____ Temperature (°C): _____

18. Place where food was stored: _____

19. *Average amount of food consumed per person fallen ill (grams):* _____

20. *Any additional information regarding infectious dose:*

21. *Characteristics of food:*

Composition: _____

Iron content: _____

Fat content: _____

pH: _____

a_w : _____

Other flora: _____

Preservative factors: _____

Type of packaging: _____

Duration of shelf-life: _____

22. Results of lab tests

Testing Laboratory:

| Specimens/Samples | Date of Sampling | Place of Sampling | Number Tested | Number Positive | Details/Comments |
|-------------------|------------------|-------------------|---------------|-----------------|------------------|
| Ill people | | | | | |
| Well people | | | | | |
| Food handlers | | | | | |
| Suspect food | | | | | |
| Other foods | | | | | |
| Environment | | | | | |

Note: *Clinical Samples

REFERENCE OF ARTICLE

- Title of paper _____

- First author/editor _____

- Affiliation of first author _____

- Other authors _____

- Title of periodical or book _____

- Volume: _____ Number: _____ Year: _____ Page nos. _____

- Issue or chapter _____

- Publishing company _____

- Place _____

-Year _____

Personal communication

Name _____

Address _____

E-mail _____ Fax No. _____

Glossary

A brief explanation of terms is given below. For more detailed explanation, refer to references 154 and 114.

| | |
|---------------------------|---|
| Attack rate | Proportion of people becoming ill after a specified exposure. |
| Case-control studies | Studies comparing the exposure of cases (those with a specified disease) with that of controls (those without the disease). |
| Case fatality ratio | Number of people dying from a specified illness in a given period divided by the number of people being diagnosed with the disease in the given period. |
| Cohort studies | Studies comparing the incidence rate of disease in exposed populations with that in non-exposed populations. |
| Incidence | Number of new cases in a given period in a specified population. The term incidence is sometimes used to denote incidence rate. |
| Incidence rate | Number of new cases in a given period in a specified population divided by the population at risk or person-time at risk. |
| Morbidity | Frequency of illness in a population, usually measured as incidence or prevalence. |
| Mortality | Frequency of death in a population, usually measured as crude or specific mortality rates. The crude mortality rate is the number of deaths in a specified period divided by the population at risk. If broken down by diagnosis this is a disease-specific mortality rate. |
| Odds ratio | In a case-control study the odds ratio is used as a measure of relative risk. It is calculated as the odds of exposure in cases divided by the odds of exposure in controls. |
| Predictive value positive | Proportion of people identified by a test or surveillance system as actually having the disease. |
| Prevalence | Number of cases in a given population at a specified point in time. |
| Prevalence rate | Prevalence divided by the population at risk. |
| Secular trends | Changes in the incidence rates occurring over a period of (many) years. |
| Sensitivity | Proportion of diseased persons detected by a test or surveillance system. |
| Sentinel surveillance | Surveillance carried out by selected "sentinel" health care providers. |