Strengthening indicator-based surveillance

Stage Two Booklet
Strengthening surveillance of and response to foodborne diseases
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Acronyms used in this module

AMR  antimicrobial resistance
CDC  Centers for Disease Control and Prevention (of the United States of America)
CUSUM  cumulative sum
EBS  event-based surveillance
ECDC  European Centre for Disease Prevention and Control
EFSA  European Food Safety Authority
EQAS  external quality assessment scheme
FAO  Food and Agriculture Organization of the United Nations
FETP  field epidemiology training programme
GFN  Global Foodborne Infections Network
GI  gastrointestinal illness
HCW  health care worker
HUS  haemolytic uraemic syndrome
IBS  indicator-based surveillance
MLST  multilocus sequence typing
MLVA  multilocus variable tandem repeat analysis
mOR  matched odds ratio
ORT  outbreak response team
OIE  World Organisation for Animal Health
PCR  polymerase chain reaction
PFGE  pulsed field gel electrophoresis
STEC  Shiga-toxin-producing Escherichia coli
TDS  total diet studies
WGS  whole genome sequencing
WHO  World Health Organization
1. How to use this module
This module is intended for countries that are in stage 2 of strengthening their surveillance and response system for foodborne diseases, and contains specific guidance on strengthening indicator-based surveillance (IBS) through laboratory identification of foodborne pathogens. Guidance is also given on conducting ad hoc research studies to supplement data from the surveillance and response system, and on how the data from the different sectors in the food supply chain can be used to conduct risk profiling.

Users of this module are encouraged to read first the introductory module of this manual, which sets the context for the guidance contained here and defines the scope and target audience. The introductory module also contains a glossary, which explains some of the technical terms used in the manual, and discusses the different risk-related terms used in the various disciplines involved in the prevention and control of foodborne diseases. It will also be useful to consult the stage 1 modules, to understand the capacities that should already be in place in stage 2.

**The present module contains specific advice on:**

- strengthening the role of laboratories in IBS;
- strengthening surveillance of notifiable diseases;
- strengthening event-based surveillance (EBS);
- rapid risk assessment of foodborne events;
- response to foodborne events;
- ad hoc research studies;
- multisectoral collaboration;
- monitoring and evaluation;
- managing implementation.
Most sections contain decision-trees, which display a step-by-step pathway for developing capacities for surveillance and response for foodborne diseases. The section on managing implementation contains a tool that countries can use to document the capacities that have already been met and the steps that need to be taken to further strengthen the system.
2. Introduction to Stage 2
A country in stage 2 of strengthening its surveillance and response system for foodborne diseases should focus on strengthening the national IBS system through laboratory characterization of priority foodborne pathogens. The national notifiable disease surveillance system should evolve from an aggregated, syndrome-based system to a case-based system that relies on laboratory identification of priority foodborne pathogens. Data from the surveillance and response system should be used to inform risk profiling. Ad hoc research studies might be required to fill specific gaps in surveillance or gaps identified during risk profiling. This module describes options for:

**strengthening the surveillance system to:**
- monitor trends and detect outbreaks of specific priority foodborne diseases;
- identify vulnerable populations;
- monitor the public health impact and effectiveness of applied control measures and policy decisions;

**strengthening the response system to ensure that:**
- multidisciplinary teams routinely investigate suspected foodborne events;
- the source of foodborne outbreaks is identified and control measures are implemented in a timely way at appropriate points along the food chain;
- the capacity to conduct analytical epidemiological studies to attribute risk is available at the local level;
developing the capacity to conduct ad hoc research studies aimed at addressing gaps identified in surveillance, such as:

- attributing food sources to specific diseases;
- understanding the foodborne disease burden in the community.

Minimum requirements

Before the surveillance and response system for foodborne diseases can be strengthened in this way, the following should be in place:

- an IBS system that can monitor trends in disease syndromes and identify foodborne outbreaks;
- an EBS system capable of detecting foodborne events;
- capacity to undertake rapid risk assessments of acute public health events, including gathering information, assessing the risk, and assigning a level of risk to further spread of foodborne events, such as outbreaks;
- multidisciplinary outbreak response, with capacity at subnational level to conduct descriptive epidemiological studies during foodborne outbreaks and at least one epidemiologist in the country who can conduct analytical epidemiological studies during foodborne disease outbreaks;
- laboratory capacity or appropriate referral pathways to support the identification of pathogens in clinical specimens during foodborne outbreaks.
Objectives of the surveillance and response system

Countries may have different needs and priorities for surveillance and response to foodborne diseases. However, all data collection should be based on well-defined objectives that lead to action to control or prevent foodborne diseases. The objectives of the surveillance and response system in stage 2 in relation to foodborne disease can include the following:

- to detect and respond to foodborne events, to allow rapid implementation of control measures;
- to monitor trends in order to understand the epidemiology of foodborne diseases, e.g. geographical distribution of diseases, seasonality and vulnerable populations;
- to identify the magnitude of the problem of foodborne diseases in the community;
- to motivate ad hoc research on foodborne diseases;
- to attribute food sources to specific foodborne diseases;
- to inform clinical management policy, where appropriate, e.g. on antimicrobial resistance;
- to monitor and evaluate interventions and measures taken to control foodborne diseases;
- to collaborate with other relevant sectors, contributing data from the surveillance and response system to help generate risk profiles.
Vision for the surveillance and response system

The vision is a description of what the surveillance and response system will look like at the end of stage 2. By the end of stage 2, there should be:

- an **indicator-based surveillance system** that includes laboratory analysis, to better understand trends in foodborne diseases and to increase the sensitivity and specificity of outbreak detection;
- a fully functional **notifiable disease surveillance system** that can monitor trends and detect outbreaks;
- a fully functional **event-based surveillance** system capable of detecting foodborne events;
- capacity for **rapid risk assessment** of foodborne events at the subnational level;
- **response** capacity at subnational level to carry out analytical epidemiological studies during foodborne outbreak investigations;
- **capacity to conduct ad hoc research studies** to fill identified gaps, e.g. to attribute food sources to specific diseases, understand foodborne disease epidemiology and estimate the burden of foodborne diseases in the community;
- **multisectoral collaboration** that facilitates the sharing of data for risk profiling.

To achieve this vision countries can focus on developing and strengthening the stage one components outlined in Figure 1. The blue area shows the components that were developed in stage 1. The green areas show the developments in the surveillance and response system in stage 2.
FIGURE 1.
Components of the surveillance and response system for foodborne diseases in stage 2

Multisectoral collaboration
- Mechanism for communication between sectors with a stake in foodborne diseases

Indicator based surveillance
Laboratory-based surveillance
- Further laboratory characterization of foodborne pathogens

Indicator based surveillance
Notifiable disease surveillance
- Individual level data routinely collected for each disease

Event based surveillance
Increasing specificity and sensitivity
- Expanding reporters to media and community leaders
- Actively scanning media for foodborne events

Rapid risk assessment of events
- Staff at subnational level can conduct rapid risk assessments of foodborne events
- Laboratory data routinely used in assessments

Response
- Subnational capacity to conduct analytical epidemiology during foodborne disease outbreaks
- Disease specific questionnaires for investigations

Ad hoc studies
Capacit y to undertake risk profiling
3. Indicator-based surveillance: strengthening the role of the laboratory
To have an indicator-based surveillance system that includes laboratory analysis, to better understand trends in foodborne diseases and to increase the sensitivity and specificity of outbreak detection, countries will need to develop or strengthen the following:

- a list of priority foodborne diseases for surveillance selected through a formal process;
- laboratory-based surveillance for priority foodborne diseases, in which cases detected through the surveillance system are confirmed and further characterized in the laboratory;
- protocols for collecting clinical specimens for all priority foodborne diseases that include:
  - objectives of the surveillance system,
  - which specimens will be collected (e.g. stool),
  - when specimens will be collected (e.g. every 20th patient meeting the case definition of diarrhoea),
  - how specimens will be collected,
  - how specimens will be stored before being transported to the laboratory,
  - how and where the specimens will be transported to;
- protocols for testing clinical specimens for all priority foodborne diseases that include:
  - a description of how laboratory testing is organized, e.g. identifying which samples from which reporting sites go to which laboratories,
instructions for the further characterization of priority foodborne pathogens,

instructions for antimicrobial susceptibility testing of foodborne pathogens and how this links to the broader antimicrobial surveillance system;

- a database to house the laboratory-based surveillance data, with a data dictionary to support the operation of the database;

- a surveillance log to document changes to the laboratory-based surveillance system;

- data reporting protocols for all priority foodborne diseases that include:
  - who will send and enter the data to the surveillance system,
  - which data will be sent,
  - how often the data will be sent, and
  - what actions will be taken based on the information sent to the surveillance system;

- antimicrobial susceptibility testing as a routine part of the surveillance system for relevant foodborne diseases.
At the beginning of stage 2, IBS is mainly focused on syndromes that are reported through the notifiable disease surveillance system. Over time, as laboratory capacity increases, it will become possible to confirm some of the etiological agents responsible for foodborne diseases. There will be a transition from a notifiable disease surveillance system based on clinical syndromes to one based on laboratory-confirmed diseases (Figure 2). The notifiable disease surveillance system developed in stage 1 will continue to operate while capacities are being developed in laboratory-based surveillance in stage 2. Strengthening the role of the laboratory may provide an opportunity to collect and analyse data from individual cases rather than aggregated surveillance data. Capturing specific information for each case, such as age, sex and place of residence, will allow more detailed analysis of surveillance data.

FIGURE 2.
Developing IBS in stage 2
Strengthening of laboratory-based surveillance for foodborne diseases should be based on existing systems and structures, where possible. Medical practitioners can collect relevant specimens from patients presenting for health care, which are sent to designated laboratories for testing to assist the doctor in making a diagnosis. When a condition is under surveillance, the diagnostic information is also important for public health purposes. The focus of this section is on strengthening laboratory services for public health surveillance and response purposes.

There are four steps to be taken in strengthening laboratory-based surveillance of foodborne pathogens:

1. Select priority foodborne diseases for surveillance;
2. Establish a sampling protocol for collecting, storing and transporting clinical specimens;
3. Establish a protocol for testing clinical specimens;
4. Establish a data-reporting protocol.

Once they have been finalized, the sampling protocol, the testing protocol and the data-reporting protocol can be combined into one document that summarizes the operation of the laboratory-based surveillance system.
Select priority foodborne diseases for surveillance

In most countries, tough decisions need to be made about how to allocate limited resources to develop sustainable surveillance and response systems that meet the specific requirements of foodborne diseases. As a starting-point, it will be important to consider what should be monitored through the surveillance system and why. A clear statement of the objectives of the surveillance system should be written. The desired sensitivity and specificity of the system should then be considered in relation to the resources available.

Increasing sensitivity can lead to a greater ability to detect:

- important changes in the trends of foodborne diseases, for example, seasonal patterns of enteric foodborne pathogens;
- outbreaks of foodborne diseases caused by foods that may have been distributed across the country or internationally.

Questions that will need to be addressed during the prioritization process include the following.

- Which foodborne diseases should be under surveillance?
- How many reporting sites and types of reporting site should be included in the surveillance system?
- Should the system cover the whole country or selected areas?
Increasing specificity can lead to a greater ability to detect:

- changes in a specific foodborne pathogen, which may help understand changes in trends of foodborne diseases; for example, changes in pathogenicity may be reflected by a higher proportion of cases being hospitalized;

- clusters of genetically similar organisms, which may suggest a common food source.

Questions that will need to be addressed during the prioritization process include the following.

- Which laboratory tests will need to be performed (e.g. for further characterization)?

- How will the laboratory system be structured to support the requirements for further characterization?

Step-by-step guidance for drawing up a list of priority diseases is given in Annex 1.
Establish a sampling protocol for collecting clinical specimens

The choice of when and where to collect clinical specimens for surveillance will depend on the systems already in place for specimen collection and testing. In some countries, for instance, there may already be a clinical practice where specimens are routinely collected and tested in a laboratory. Any strategies to strengthen laboratory-based surveillance should build on the systems that are already in place.

It is important to establish a sampling protocol for the collection of clinical specimens for laboratory-based surveillance. The sampling protocol should specify the following:

- the objectives of the surveillance system;
- which specimens will be collected (e.g. faeces, blood, etc.); the stage 1 module contains a list of foodborne diseases and the appropriate specimens to be collected (reproduced from WHO, 2008a);
- when specimens are to be collected (e.g. every 20th patient meeting the case definition of diarrhoea);
- how specimens should be collected (guidance on collecting clinical specimens is given elsewhere (WHO, 2008a));
- how specimens should be stored before being transported to the laboratory (guidance on storing clinical specimens is given elsewhere (WHO, 2008a));
- where the specimens need to be transported to.
Countries where clinical specimens are not routinely collected

For countries where clinical specimens are not already routinely collected, there are three options for collecting clinical specimens for laboratory-based surveillance.

- Strategically select a limited number of sites and collect specimens from all or a random selection of patients meeting a case definition (sentinel surveillance).
- Collect specimens from patients with severe illness (e.g. those admitted to hospital) or from patients who have died from a suspected foodborne illness (severity-based surveillance).
- Collect specimens from patients whenever clinicians recognize a clustering of a particular clinical syndrome, by time, place or person (cluster-based surveillance).

It will be important to weigh up the potential benefits and challenges of the three approaches. These are summarized in Table 1.
TABLE 1.
Benefits and challenges of the different surveillance options for collecting clinical specimens

<table>
<thead>
<tr>
<th>Surveillance option</th>
<th>Benefits</th>
<th>Challenges</th>
</tr>
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<tbody>
<tr>
<td>Sentinel surveillance</td>
<td>• Ongoing specimen collection&lt;br&gt;• Can use existing sentinel surveillance system established for other diseases, such as influenza-like illness&lt;br&gt;• Resources can be concentrated on a limited number of sites&lt;br&gt;• Information is collected on pathogens causing mild and severe illnesses</td>
<td>• May be costly, as more specimens may be processed using this approach than in the other two options&lt;br&gt;• Low sensitivity for cluster detection&lt;br&gt;• In many countries, those who present to health facilities with acute diarrhoea are often small children, many of whom are infected with rotavirus or other agents that are not foodborne</td>
</tr>
<tr>
<td>Severity-based surveillance</td>
<td>• Comprehensive understanding of pathogens causing severe illness&lt;br&gt;• Does not require establishment of specific sites&lt;br&gt;• Approach best suited to identify pathogens such as Salmonella typhi and enterohaemorrhagic Escherichia coli</td>
<td>• Cost of training hospital staff to collect appropriate specimens from severely ill patients&lt;br&gt;• Etiology of severe illness will not accurately represent true pathogen burden in the community; some pathogens may not be represented at all&lt;br&gt;• Sample collection dependent on clinical outcomes rather than ongoing&lt;br&gt;• Low sensitivity for cluster detection</td>
</tr>
<tr>
<td>Cluster-based surveillance</td>
<td>• Most likely to identify etiological agent in an outbreak situation, because clinicians collect specimens at the first sign of clustering</td>
<td>• Favours identification of epidemic-prone pathogens, which may not accurately represent true pathogen burden in the community&lt;br&gt;• Health care staff will require training to identify and report clusters&lt;br&gt;• Widespread outbreaks with cases scattered over a large area may go unnoticed</td>
</tr>
</tbody>
</table>
The additional costs for sentinel surveillance will depend on how much use can be made of existing systems. Every effort should be made to build on existing systems. For example, it may be possible to build foodborne disease sentinel surveillance on surveillance for influenza-like illness, by using the same:

- sentinel clinics or hospitals: the clinical staff will have already been trained to take part in a surveillance system;
- surveillance and laboratory reporting forms: staff will already be familiar with the reporting forms, which can be adapted to cover foodborne diseases;
- sample transport systems: the protocols for sample packaging and transport will be in place.

It will be necessary to determine if the existing sentinel sites and the laboratories performing the testing have the capacity to undertake surveillance for other diseases and syndromes. The addition of foodborne diseases should not compromise the existing surveillance system.

If there is no existing sentinel surveillance, it will be necessary to recruit clinicians to collect the specimens and report to the surveillance system. This may present a challenge if clinicians do not perceive that they have a role in public health. It might be necessary to consider incentives for clinician participation. However, it is important that the incentives are formalized (e.g. accreditation points) and do not bias the surveillance system. Feedback to clinicians from the surveillance system, in the form of surveillance bulletins, can also show them how the information they collect is used for public health purposes.
It will also be necessary to identify the most appropriate laboratory to test the clinical specimens; several options may be available. Transporting specimens can be difficult, so it is advisable to choose a laboratory as close as possible to where the specimens are collected.

Regardless of the options chosen for specimen collection, there will be costs for:

- the training of clinical staff to recognize the circumstances in which they should collect specimens;
- collection, storage, packaging and transport of the specimens.

Countries where clinical specimens are routinely collected

For countries where specimens are already collected for laboratory testing for priority foodborne diseases, only minor adjustments might be needed to ensure that data are sent to local health authorities and the national surveillance system.

If specimens are being collected but not routinely tested for priority foodborne pathogens, it will be necessary to determine whether existing laboratories are able to conduct the required testing or whether samples should be referred to a regional or national public health laboratory. This option will require specific funding to cover the costs of testing at the chosen laboratory and training the laboratory staff. Figure 3 shows the options for organizing testing for specific foodborne pathogens in countries where specimens are routinely collected.
Establish a protocol for testing clinical specimens

There are three aspects to consider when establishing a protocol for testing of clinical specimens for foodborne pathogens.

1. The organization of laboratory testing should be well understood, to ensure that specimens are referred to the laboratories that can perform the required tests.

2. The requirements for further characterization of priority foodborne pathogens must be defined.

3. Antimicrobial susceptibility testing of foodborne pathogens should be part of a broader antimicrobial surveillance system.
Laboratories are gradually moving towards culture-independent diagnostic tests, such as polymerase chain reaction (PCR), to detect pathogens, including foodborne pathogens. PCR is suitable for diagnostic testing, as it provides a rapid and generally reliable result. However, PCR does not allow the further characterization of foodborne pathogens required for public health purposes. For each priority pathogen, countries will need to define which results are sent to the surveillance system; for example, should PCR-positive, culture-negative results be sent to the surveillance system? PCR results have limited use for detecting clusters of disease, but a PCR-positive result combined with exposure information from the clinician requesting the testing may provide important information for an outbreak investigation.

Organization of laboratory testing

Collected specimens will need to be transported to a laboratory that can test for the priority foodborne pathogens. Depending on the laboratory services available, it might be necessary to refer isolates from positive patients to a public health laboratory or reference laboratory for further characterization.

Ideally, laboratory-based surveillance would use existing diagnostic testing systems to identify cases of disease. Depending on how the laboratory system is structured in a country, this can require the support of:

- **public health laboratories**: these are based in the public sector (and sometimes the private sector) and their primary role is to conduct further typing of isolates to support the surveillance and response system;

- **national and international reference laboratories**: these are centres of excellence that are able to use sophisticated laboratory techniques to support the surveillance and response system;
hospital laboratories: these are based in hospitals in either the public or private sector and provide diagnostic services to clinicians;

private laboratories: these are based in the private sector and provide diagnostic services to clinicians.

Each country will have its own laboratory referral pathways to support surveillance and response, but a generic flowchart is shown in Figure 4. The overall system should focus on meeting the needs of clinicians and public health practitioners. The primary role of the hospital and private laboratories is to make a diagnosis to inform clinical management. The laboratory result should be sent both to the requesting clinician and to the local health authorities managing the surveillance system. For priority pathogens, specimens should be referred to a public health laboratory for further characterization of the pathogen (also known as pathogen typing). Typing of common foodborne pathogens is necessary to identify clusters and outbreaks and more precisely understand disease trends. For example, there are over 2000 serovars of non-typhoidal *Salmonella* and further characterization can detect clusters of similar organisms that may suggest a common food source. As specific serovars of *Salmonella* may be associated with specific types of food, further characterization of isolates will also help guide control measures. National and international reference laboratories can be used for additional further characterization of isolates, especially during outbreak investigations.
Persuading private and hospital laboratories to participate in laboratory-based surveillance can be difficult, as they often do not perceive public health as their responsibility. Strategies to encourage participation should be considered (e.g. payments for the cost of transporting isolates to a public health laboratory and reporting to the surveillance system).
Further characterization

Further laboratory characterization of foodborne pathogens is vital for detecting foodborne disease outbreaks. The level of characterization required to detect outbreaks is rarely used to direct patient care, with the exception of antimicrobial resistance (AMR) testing. Private and hospital pathology laboratories are, therefore, unlikely to conduct this testing.

At the most basic level, it can be important to identify the species, as different species may have different epidemiological characteristics and sources. However, for some types of foodborne pathogens, such as Salmonella and Shigella, further testing is needed. Several tests are commonly used to characterize foodborne pathogens, including:

- serotyping;
- phage typing;
- pulsed-field gel electrophoresis (PFGE);
- multilocus variable tandem repeat analysis (MLVA);
- whole genome sequencing.
Stage two

Surveillance data – and hence the results of further laboratory characterization – need to be comparable across provinces, states or territories, to provide a national perspective. Usually this will require a high degree of interaction between reference laboratories and agreement to use consistent methods of testing, reagents, equipment, and nomenclature. Guidance is available for strengthening public health laboratory networks to support disease surveillance (WHO & CDC, 2008).

It is also important to ensure that the laboratories contributing results to the surveillance system have quality management systems in place, to ensure that the results are accurate, timely and reliable. WHO has produced a handbook on laboratory quality management systems (WHO, 2011). As laboratory capacity is strengthened and quality management systems are put in place, laboratories may consider participating in an external quality assessment scheme (EQAS). Such a scheme leads to the identification of deficiencies in laboratory practice, which then guides efforts to improve detection and reporting of pathogens. Specific guidance on introducing an EQAS has been published by WHO (WHO, 1999a; 2011). An EQAS can be used for any type of test performed in a laboratory; foodborne diseases could be added to the list of agents to be tested for in an EQAS survey. An example is presented as case study 1.

The Global Foodborne Infections Network (GFN) runs an EQAS for foodborne pathogens, and reports from the scheme are published annually (www.who.int/gfn/activities/eqas/en/). In 2013, participating laboratories received eight anonymous strains of Salmonella, four Shigella strains, two Campylobacter isolates and one unknown isolate (Escherichia coli O157:H16) for identification (Hendriksen et al., 2014).
Case Study 1.

Including foodborne pathogens in an external quality assurance scheme in Africa

From 2002 to 2009, public health laboratories and related facilities across Africa were invited to participate in an EQAS, which included bacterial enteric diseases, bacterial meningitis, plague, tuberculosis and malaria. The bacterial enteric pathogens included *Salmonella* spp, *Shigella* spp, *Vibrio cholerae*, *Salmonella enterica* serovar Typhi, *Escherichia coli* and *Campylobacter jejuni*. Surveys were sent annually to test participants’ diagnostic proficiency and the results were assessed by referees. Identification was found to be acceptable in 65% of challenges for bacterial enteric pathogens, but serotyping and antibiotic susceptibility testing and reporting were frequently incorrect. This assessment helped identify issues that provided an evidence base for future laboratory strengthening activities.

Source: Frean et al., 2012.

Further characterization may not be needed for every clinical specimen. Requirements for further characterization will depend on the pathogen and the circumstances. Annex 2 outlines the types of further characterization that are appropriate for different foodborne bacterial pathogens. Countries will need to define requirements for further characterization for each priority foodborne
pathogen and map the laboratories in the country that can perform the testing. This process can also help identify possible gaps in laboratory-based surveillance and areas that may require additional support. Annex 3 contains a template for mapping the laboratory testing capacities within a country.

The global food chain is complex and food destined for one country may have been produced and processed in multiple countries. Therefore, the detection of and response to international foodborne outbreaks is only possible with international comparison of strains collected through IBS. Laboratories can submit genetic sequences or other information that allows comparison of pathogens across countries. Box 1 lists some networks and databases to which laboratories can upload genetic information on foodborne pathogens for international comparison. It is important to recognize that these networks are voluntary and the data in the databases are not necessarily representative of the diversity of pathogens in any given country.

There have been numerous examples of successful interventions following investigation of contaminated foods that have been distributed internationally, including turkey contaminated with *Salmonella* Stanley (Kinross et al., 2014) and watermelon contaminated with *Salmonella* Newport (case study 2). Sharing of laboratory results from genetic testing of pathogens and epidemiological information from investigations of these outbreaks was vital to identifying the common source of the outbreak.
BOX 1.
Examples of databases for international comparison of foodborne pathogens

- **PulseNet International** ([http://www.pulsenetinternational.org/](http://www.pulsenetinternational.org/)). This is a network of national and regional laboratory networks dedicated to detecting clusters of foodborne disease worldwide ([Swaminathan et al., 2006](Swaminathan et al., 2006)). Each laboratory uses standard genotyping methods and shares data to allow the detection of foodborne disease outbreaks that cross international borders. The international network has evolved from the American system, PulseNet.

- **PubMLST** ([http://pubmlst.org](http://pubmlst.org)). This contains multiple databases for a range of different bacteria MLST schemes. Some of the foodborne pathogens included are *Bacillus cereus*, *Campylobacter*, *Vibrio cholerae* and *Vibrio parahaemolyticus*. Laboratories can download allelic profiles and sequence types, and can contribute their MLST results to the database for comparison. The databases are hosted by the PubMLST website at the Department of Zoology, University of Oxford, England.

- **GenBank** ([http://www.ncbi.nlm.nih.gov/genbank/](http://www.ncbi.nlm.nih.gov/genbank/)). This database, housed at the National Institutes of Health (NIH) in the USA, contains genetic sequences of various bacteria and viruses including foodborne pathogens. GenBank is part of the International Nucleotide Sequence Database Collaboration, which comprises the DNA DataBank of Japan, the European Molecular Biology Laboratory, and GenBank at the National Centre for Biotechnology Information in the United States. Laboratories can upload sequences to the database and compare their sequences with others in the database.
HAVNET (www.rivm.nl/en/Topics/H/HAVNET/Database). This database contains hepatitis A sequences from around the world and is hosted by the National Institute for Public Health and the Environment in the Netherlands. HAVNET contains entries from GenBank, but also includes entries submitted by participating members in the network.

Institut Pasteur MLST databases (www.pasteur.fr/mlst). These databases contain sequences and sequence types (STs), which are freely available. Databases for a range of bacteria are hosted on the website. The main database of interest for foodborne diseases is for Listeria monocytogenes.

CASE STUDY 2.
How further characterization and sharing of laboratory results identified a multinational outbreak of Salmonella Newport

In 2011, Salmonella Newport was detected in a ready-to-eat slice of watermelon as part of a food survey in England. A total of 63 human cases of Salmonella Newport infection were reported in England, Wales, Northern Ireland, Scotland, Ireland and Germany. Isolates were indistinguishable by pulsed-field gel electrophoresis and matched that from the watermelon isolate. Forty-six patients who met the case definition were interviewed, of whom 27 reported eating watermelon. Further investigations, including trace-backs, confirmed that the outbreak was linked to consumption of imported watermelon.

Source: Byrne et al., 2014.
Antimicrobial susceptibility testing

Antimicrobial drugs are used to treat bacterial infections. Even though most foodborne diseases do not need such treatment, it is important to conduct susceptibility testing to detect resistance in individual bacterial isolates for epidemiological purposes. If an isolate is resistant to antimicrobial drugs, those drugs cannot be used to treat the infection in the person from whom the isolate came. This can lead to poor health outcomes for the individual and also pose a threat to public health. It is therefore important that antimicrobial susceptibility testing on clinical isolates is conducted routinely and accurately.

Antimicrobial susceptibility testing is conducted mainly on non-foodborne pathogens; however, it is important that any surveillance for antimicrobial resistance includes priority foodborne pathogens. WHO guidance is available on how to perform antimicrobial susceptibility testing (WHO, 2003). Guidance on surveillance for antimicrobial resistance is currently under development.

Establish a data-reporting protocol

The data-reporting protocol is important because it documents:

- who will send the data to the surveillance system;
- what data will be sent;
- how often data will be sent; and
- what actions will be taken on the basis of the information sent to the surveillance system.
Once a pathogen has been identified at a laboratory, the results need to be recorded and sent to the treating clinician. The responsibility for reporting laboratory-confirmed cases to the surveillance system may rest with the clinician, the laboratory or both. The reports should be sent to the local health authorities responsible for surveillance and response. The data are then collated with data from other sites (if there is more than one participating laboratory or sentinel site) and sent to the national laboratory-based surveillance system.

Early in the development of a laboratory-based surveillance system, a stand-alone database will need to be set up to house the data from the laboratories. The database will need to be able to capture the relevant laboratory results and the demographic details of the patient. A data dictionary should support the operation of the database and a surveillance log should be used to document changes to the surveillance system. As the surveillance system develops and specific diseases are made nationally notifiable, the laboratory results will enter the notifiable disease surveillance system database. Section 4 gives further information on this subject.

Each laboratory will have its own information management system to store information about specimens and the results of testing. The key information that needs to be sent to the local authorities responsible for the surveillance system is:

- laboratory identification number;
- unique patient identification number;
- patient’s first name;
- patient’s surname;
- date of birth;
- sex;
- address;
- name and address of the health care facility sending the sample;
Stage two

- type of specimen (e.g. faeces, blood, etc.);
- date of specimen collection;
- date of receipt at the reporting laboratory;
- agent identified;
- antimicrobial susceptibility testing results; any clinical or exposure information (e.g. travel), if available.

It is important that the patient’s identity is transmitted to the surveillance system at the local level so that patients can be interviewed if required, and so that duplicate records can be removed from the system. It is, however, essential to maintain patients’ confidentiality at all times. Names and addresses of patients should be seen only by laboratory staff, the treating clinician and local health staff with specific responsibility for surveillance and response. When the data are sent from the local level to the national surveillance system, identifying information, such as patient name and address, should not be included.

In the early stages of laboratory-based surveillance, data may be sent weekly or monthly from the laboratories to the surveillance system. However, if one of the objectives of the surveillance system is to detect outbreaks, it will be necessary eventually to increase the frequency of reporting. The capacity to report laboratory results in a timely manner should be considered when assessing the feasibility of making laboratory-confirmed diseases nationally notifiable.

The data-reporting protocol should also specify what will be done with the data in the surveillance system. For example, local surveillance bulletins may be produced to send feedback to the clinicians and laboratories contributing to the system.
It will also be necessary to document what the local health authorities should do if an outbreak is detected through the laboratory-based surveillance system. For example, if a potential foodborne disease outbreak is detected, a rapid risk assessment should be conducted and an investigation launched, if appropriate.

Options for strengthening laboratory-based surveillance

Box 2 provides a summary of the options for strengthening laboratory-based surveillance of foodborne diseases in stage 2. This information is also summarized in the decision-tree in Figure 5.

**BOX 2.**

**Summary of options for strengthening laboratory-based surveillance for foodborne diseases**

- Select the priority foodborne pathogens for inclusion in the laboratory-based surveillance system (Annex 1).
- Establish a sampling protocol for collecting specimens.
  - If clinical specimens are not already routinely collected, consider collecting specimens:
    - through sentinel surveillance sites;
    - from patients with severe illness;
    - from patients with a similar illness clustered in time and place.
If clinical specimens are routinely collected, examine whether laboratories are able to report results for priority foodborne pathogens to the laboratory-based surveillance system.

- Establish a protocol for testing specimens.
- Map laboratory capacities for further characterization of bacterial foodborne pathogens in the country.
- Encourage participation in an external quality assessment scheme, so that the quality of testing can be monitored in a standard way.
- Consider including priority foodborne pathogens in any antimicrobial resistance surveillance system.

- Establish a database for the laboratory-based surveillance data. A data dictionary will be needed to support the operation of the database and a surveillance log to document changes made to the surveillance system.

- Establish a protocol for reporting data to the surveillance system.
- Establish contact with international reference laboratories for pathogen characterization.
- Consider sharing molecular patterns of relevant pathogens in an international database to assist in the detection of foodborne outbreaks that may cross international boundaries.
### for strengthening laboratory-based surveillance in stage 2

<table>
<thead>
<tr>
<th>List of foodborne diseases and the appropriate specimens to be collected</th>
<th>Stage 1 module, Annex 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges and benefits of different surveillance options for collecting specimens</td>
<td>Table 1</td>
</tr>
<tr>
<td>Prioritizing foodborne diseases for surveillance</td>
<td>Annex 1</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Further characterization of bacterial foodborne pathogens</td>
<td>Annex 2</td>
</tr>
<tr>
<td>Mapping laboratory capacities for further characterization of bacterial foodborne pathogens</td>
<td>Annex 3</td>
</tr>
<tr>
<td>Steps to strengthen laboratory-based surveillance</td>
<td>Figure 5</td>
</tr>
</tbody>
</table>
FIGURE 5.
Decision-tree to identify the steps a country can take to strengthen laboratory-based surveillance for foodborne diseases in stage 2

Have the priority foodborne pathogens for laboratory-based surveillance been established?

- **YES**
  - Are clinical specimens being routinely collected from patients?
    - **YES**
      - Are specimens being tested for priority foodborne pathogens under surveillance?
        - **YES**
          - Identify further characterization requirements for each pathogen and map the laboratories able to perform the necessary testing (Annex 3).
          - Document this in the laboratory testing protocol.
        - **NO**
          - Explore whether specimens can be tested at the diagnostic laboratory or need to be sent to a public health laboratory.
          - Establish a laboratory testing protocol.
    - **NO**
      - Identify priority foodborne pathogens (Annex 1)
  - **NO**
    - Consider surveillance options (e.g. sentinel surveillance).
    - Explore if formal, sustainable incentives could be offered to clinicians to collect specimens for testing.
    - Establish a specimen collection protocol.

- **NO**
  - Have the requirements for further characterization of priority foodborne pathogens been documented and are the further characterization tests being performed?
    - **YES**
      - Is there a database to house the laboratory-based surveillance data?
        - **YES**
          - Are laboratory results being reported to the laboratory-based surveillance system?
            - **YES**
              - Identify antimicrobial susceptibility testing being performed on priority foodborne pathogens?
                - **YES**
                  - Are laboratories using methods and reporting nomenclature that allow results to be compared across the country?
                    - **YES**
                      - Capacities for laboratory-based surveillance in stage 2 have been established
                    - **NO**
                      - Explore with laboratories participating in the surveillance system whether they could carry out antimicrobial susceptibility testing of priority foodborne pathogens.
                - **NO**
                  - Establish a laboratory testing protocol.
            - **NO**
              - Establish a data-reporting protocol.
        - **NO**
          - Explore whether specimens can be tested at the diagnostic laboratory or need to be sent to a public health laboratory.
          - Establish a laboratory testing protocol.
    - **NO**
      - Explore whether specimens can be tested at the diagnostic laboratory or need to be sent to a public health laboratory.
      - Establish a laboratory testing protocol.
  - **NO**
    - Ensure there is a database to house the laboratory-based data.
    - Establish a database to house the laboratory-based data.
    - Ensure there is a data dictionary to support the database.
    - Ensure there is a surveillance log to document changes in the surveillance system.

- **NO**
  - Are antimicrobial susceptibility testing being performed on priority foodborne pathogens?
    - **YES**
      - Are laboratories using methods and reporting nomenclature that allow results to be compared across the country?
        - **YES**
          - Establish a laboratory testing protocol.
        - **NO**
          - Advocate for methods and reporting nomenclature that allow laboratory results to be compared across the country.
    - **NO**
      - Establish a laboratory testing protocol.
  - **NO**
    - Establish a data-reporting protocol.
    - Explore mechanisms for the laboratories to report results to the surveillance system.
    - Explore whether sustainable incentives could be offered to laboratories.
    - Establish a data-reporting protocol.
4. Indicator-based surveillance: strengthening the notifiable disease surveillance system
For a fully functional notifiable disease surveillance system that can successfully monitor trends and detect outbreaks, countries will need to ensure the following:

- existing laws and decrees governing the national notifiable disease surveillance system are up to date and include priority foodborne diseases;
- there are case definitions for each of the notifiable foodborne diseases;
- there are notification forms and a clear mechanism for reporting (e.g. fax number, telephone notification, web-based system);
- laboratories and health care workers:
  - are aware of their obligations to report positive test results to the surveillance system,
  - have specific forms for notification of cases,
  - have clear instructions for reporting that fits within the existing surveillance system;
- there is a notifiable disease surveillance system database that:
  - can record all the information required under the minimum data requirements,
  - allows data to be entered easily,
  - allows data to be extracted easily for analysis,
  - can be accessed at any time,
Stage two

- is relatively stable over time to enable trends to be monitored;
- to support the surveillance processes, there is:
  - a data dictionary,
  - a surveillance system log,
  - a disease-specific surveillance log;
- the surveillance data from both the notifiable disease surveillance system and the laboratories are analysed and interpreted regularly;
- data analyses are included in a regular surveillance bulletin that is available to all stakeholders;
- surveillance protocols include the list of notifiable diseases with, for each disease:
  - a case definition,
  - the reason for surveillance,
  - a data analysis plan for monitoring trends and the thresholds used for cluster detection,
  - the public health action required (e.g. response triggered by one case or a cluster of cases).

As a country moves into stage 2, the notifiable disease surveillance system evolves from collecting aggregated data on syndromes to individual-level data on laboratory-confirmed cases of illness. Many of the options presented here relate specifically to foodborne diseases, but can be applied equally to other notifiable diseases under surveillance. Strengthening notifiable disease surveillance is a long-term process, which needs to focus on developing a sustainable system.
It is important that countries entering stage 2:

- focus on strengthening their existing surveillance system for notifiable syndromes and diseases before considering expanding the list of notifiable conditions;

- bear in mind that adding too many diseases to the national notifiable disease list can overwhelm and compromise the entire system; in extending the national notifiable disease surveillance system to include foodborne diseases, only priority diseases should be included (Annex 1 contains guidance for prioritizing diseases for surveillance);

- ensure that the surveillance of any priority diseases added to the existing notifiable syndrome and disease surveillance system is complementary to existing practices and is sustainable.

List of diseases and syndromes under surveillance with case definitions

Before priority foodborne diseases can be added to the notifiable disease surveillance system, the following must be in place:

- a fully functional notifiable disease and syndrome surveillance system that can monitor trends and detect events; and

- the capacity to carry out sustainable laboratory-based surveillance.

Once a priority list of foodborne diseases has been drawn up, existing laws or decrees that govern notification to the national disease surveillance system will need to be amended accordingly. In general, the hazards that would be made notifiable are microbial pathogens, as foodborne chemical hazards are not routinely measured through surveillance systems (see section 8).
Case definitions will need to be drafted for each disease to be included in the surveillance system. The case definitions should describe the laboratory and clinical evidence required for a patient to be considered as a case for surveillance purposes. Some examples of case definitions are given elsewhere (WHO, 1999b). It is important to work with the laboratories that will be testing for priority foodborne pathogens to ensure that their methods provide the level of evidence required in the case definitions.

**Notification process**

Depending on the notification process in a country, laboratories and health care workers will be required to report to the notifiable disease surveillance system. Laboratories and health workers need to be made aware of their obligations to report positive test results to the surveillance system. The following steps should be undertaken to facilitate reporting:

- ☑ provide guidance and training to health care workers and laboratories on the conditions that are notifiable and their case definitions;
- ☑ create specific notification forms for use by health care workers;
- ☑ create a mechanism for reporting that fits within the existing surveillance system. It is important that the process for notifying is simple and rapid. Timely reporting is an essential requirement of a notifiable disease surveillance system that is designed to detect outbreaks. Reporting may be done by fax, phone or through a web-based system.

If both health care workers and laboratories have an obligation to report to the surveillance system, it is important that the clinical information about patients can be linked with their laboratory test results. Ideally, this is done using the patient’s name and date of birth. If it is decided not to send personal identifying information to the surveillance system at the local level, it will be necessary to
consider alternatives, such as a unique identification number for each patient that accompanies both the clinical specimen and the notifications from health care workers and laboratories.

**Database to store surveillance data**

As the notifiable disease surveillance system starts to receive notifications about individuals from health care workers and laboratories, the management of the data will become increasingly complex. In stage 1, the surveillance database houses aggregated data on each notifiable condition. In stage 2, as specific diseases are added to the notifiable disease surveillance system, the existing surveillance database will need to be modified, or a new database created, to store individual-level data. The minimum data requirements for the database will need to be defined. Annex 4 provides an example of a minimum dataset for surveillance of foodborne diseases in stage 2. These data fields apply not only to foodborne diseases, but potentially to all diseases included in the notifiable diseases surveillance system.

It is important that the surveillance database:

- can record all the information required under the minimum data requirements;
- allows data to be entered easily, therefore reducing possible data entry errors;
- allows data to be extracted easily for analysis;
- can be accessed at any time;
- is stable (i.e. the fields in the database do not change much over time).
Depending on the skills and financial resources available, it may be possible to build a surveillance database or to have it built by expert database developers. In both cases, it will be crucial to map:

- the objectives of surveillance;
- processes: how the data flow through the system from data entry to analysis;
- outputs: this may include surveillance bulletins, annual reports, outputs from cluster detection methods, weekly surveillance summaries, etc.
- resources: this covers all the resources required to support the system, including staff (database administration, public health staff), budgets and equipment (e.g. computers, faxes, printers).

The specifications and business requirements of the database will need to be carefully defined, to make it easier for the developer to provide a database with the necessary functionality.

The following should also accompany the database.

- **Data dictionary.** This should provide details of each data field and specify how information should be entered into the database. Annex 5 contains an example of a data dictionary, which builds on the dictionary developed in stage 1.

- **Surveillance log.** All changes made to the notifiable disease surveillance system during stage 2 should be documented in the surveillance log. An example of a surveillance log is given in Annex 6.
Disease-specific surveillance logs. Once the database starts to collect individual-level data for specific laboratory-confirmed diseases, a separate surveillance log should be established for each disease. Over time, case definitions and laboratory methods used to identify the pathogens under surveillance may change. All these changes should be documented in disease-specific surveillance logs, to allow consistent interpretation of the data over time.

Regular analysis

Notifiable disease surveillance data should be regularly reviewed for trends and for clusters of foodborne disease. The data should be able to describe the epidemiology of each disease by time, place and person. Appropriate analyses to consider include the following.

Notification rates

Notification rates are useful for comparing notifications of diseases in different populations. To calculate notification rates, demographic data are required for the denominator. These may be difficult to obtain if the populations of interest are not recorded in the national census. Two main types of rates can be calculated.

**Crude notification rates** are calculated by dividing the number of notifications of a specific disease by the number of people in the population of interest. The example in Table 2 shows that the crude notification rate in subgroup A was higher than in the other subgroups.
TABLE 2.
Comparison of crude notification rates in three subgroups

<table>
<thead>
<tr>
<th>Population</th>
<th>Crude notification rate (per 100 000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgroup A</td>
<td>35.9</td>
</tr>
<tr>
<td>Subgroup B</td>
<td>13.6</td>
</tr>
<tr>
<td>Subgroup C</td>
<td>18.5</td>
</tr>
</tbody>
</table>

**Standardized notification rates** use a reference population to account for underlying age and sex differences between different areas. The demographic data for the reference population should be structured in the same way as the data for the populations covered by the surveillance system (e.g. by 5-year age groups). The rates in the surveillance populations are then adjusted to the reference population. For example, age-standardized notification rates can be used to compare disease burden in different provinces within a country, using the national population as the reference population.

**Epidemic curves**

The number of cases occurring over a given period can be displayed in a histogram. These are especially useful for examining long-term trends and for detecting clusters. The example shown in Figure 6 demonstrates a seasonal effect, with a peak in the number of notifications each year in December and January.
Bar charts showing notification rates by age group and sex can be especially useful in identifying vulnerable groups and enabling valid comparisons between the groups. Basic demographic data can be used to calculate the notification rates per 100 000 population. Figure 7, for example, shows a bar chart for an infection for which the highest notification rates are in children aged 0–4 years and people aged over 60 years.
Mapping

Maps of notification rates may help identify areas that have a greater burden of specific foodborne diseases. Basic demographic data (e.g. population estimates for each of the geographical regions of interest) will be needed to calculate the notification rates. An example of such a map is shown in Figure 8.
FIGURE 8.
Map showing incidence rates of *Salmonella* Stanley cases in selected European Union Member State regions, 1 August 2011 to 22 October 2012

Thresholds for cluster detection

Clusters are most often defined in relation to time and place. It is important to recognize that epidemiologically linked cases may occur that are below the threshold for investigation, but that may nevertheless be important to follow up. Examples are foodborne disease in vulnerable subpopulations, such as infants, and severe illness. In other cases, limited public health resources may be insufficient to allow small clusters to be fully investigated.

Source: Kinross et al., 2014.
Cluster detection methods range from simple calculations of historical averages to complex statistical modelling. The stage 1 module contains information on thresholds. In stage 2, more advanced thresholds and cluster detection methods may be useful. Robertson et al. (2010) reviewed some methods for detecting outbreaks using surveillance data, including cumulative sums (CUSUMs), scan statistics and model-based approaches. Case study 3 describes the application of CUSUMs to detect clusters of *Salmonella* cases, while case study 4 describes the use of scan statistics to detect clusters of *Listeria monocytogenes* infection. The common requirements of all these approaches are:

- Further characterization of pathogens to group genetically similar organisms;
- Several years of stable, reliable surveillance data for genetically similar organisms.

**CASE STUDY 3.**

**Applying a CUSUM method to Salmonella surveillance data**

A computer algorithm based on the CUSUM method was developed. The algorithm cumulated sums of the difference between frequencies of Salmonella isolates and their expected means. A CUSUM was calculated for each Salmonella serotype for each week in a one-year period and compared with the same week over the previous 5 years, using either the mean or the median of the 5 weeks. A 15-week mean was also assessed (using the mean over a 3-week interval for the past 5 years). Sensitivity, specificity and false-positive rates were assessed for *Salmonella* Enteritidis outbreaks in each state of the USA.
Sensitivity was defined in terms of the number of outbreaks flagged by the algorithm that matched reported outbreaks.

Specificity was based on the number of weeks not flagged that corresponded to weeks without reported outbreaks.

False-positive rate was the proportion of flags that did not correspond to outbreaks over the total number of flags.

Sensitivity by state in which outbreaks were reported varied from 0% (0/1) to 100%, specificity was 64–100%, and the false-positive rate was between 0 and 100%. The data need to be interpreted with caution, as there were some limitations, including size of outbreak, lack of reporting of isolates, duplicate isolate reports, and under-reporting because of limited resources to investigate small outbreaks.

Source: Hutwagner et al., 1997.

CASE STUDY 4.

Using scan statistics to detect clusters of Listeria monocytogenes based on ribotyping and PFGE types

The ribotype and PFGE type of 131 human Listeria monocytogenes isolates, collected in New York State (USA) between November 1996 and June 2000, were compared to look for clusters of genetically similar organisms. A scan statistic was used to detect listeriosis clusters. The scan statistic assumes an underlying Poisson distribution and a stable population at risk over time, and is useful for rare events. This statistical test compares the incidence of events within a defined window of time against the incidence of events outside the window. Given that the incubation period for L. monocytogenes can be up
to 70 days, the time windows tested in this study were one month and three months. Nine clusters (total 41 cases; 31% of cases) were identified by ribotype or PFGE; five clusters (18% of cases) were identified using both methods. Two of the nine clusters (13% of cases) corresponded with investigated multistate listeriosis outbreaks. All clusters detected within the one-month window were also detected in the three-month window.

Source: Sauders et al., 2003.

Once appropriate cluster detection methods have been identified, the use of such techniques should become a routine function of the surveillance system. Any alerts generated will need to be considered within the rapid risk assessment process to determine whether further investigation is required. Staff working with the notifiable disease surveillance and response system should also regularly examine the data for any unusual features in new notifications, which may indicate the beginning of an outbreak (e.g. a higher than normal number of infants notified with a common type of Salmonella may indicate contamination of infant formula or an outbreak at a child care centre).

Public health staff should meet weekly to discuss surveillance data, with a particular focus on the detection of clusters and results of investigations. Foodborne diseases should be specifically considered during these team reviews. Short daily meetings could also be considered for critical updates.
Regular publication of data in surveillance bulletins

The outputs from the data analysis and the use of thresholds to identify clusters should be published in a surveillance bulletin. The bulletin provides feedback to the health care staff who collect the surveillance data and can also provide an evidence base for developing policy and future interventions. Table 3 contains web links to examples of surveillance bulletins for foodborne diseases.

### TABLE 3.
Web links to surveillance bulletins for foodborne diseases

<table>
<thead>
<tr>
<th>Country or region</th>
<th>Web link</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surveillance bulletins</strong></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td><a href="http://www.eurosurveillance.org">www.eurosurveillance.org</a></td>
</tr>
<tr>
<td>USA</td>
<td><a href="http://www.cdc.gov/mmwr/index2015.html">http://www.cdc.gov/mmwr/index2015.html</a></td>
</tr>
<tr>
<td><strong>Annual reports on foodborne diseases</strong></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td><a href="https://www.nml-lnm.gc.ca/NESP-PNSME/index-eng.htm">https://www.nml-lnm.gc.ca/NESP-PNSME/index-eng.htm</a></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.phac-aspc.gc.ca/foodnetcanada/publications-eng.php#a3">www.phac-aspc.gc.ca/foodnetcanada/publications-eng.php#a3</a></td>
</tr>
<tr>
<td>USA</td>
<td><a href="http://www.cdc.gov/foodnet/reports/index.html">http://www.cdc.gov/foodnet/reports/index.html</a></td>
</tr>
</tbody>
</table>

Surveillance protocols

Building on the surveillance protocols developed during stage 1, it will be important to have a description of how the surveillance system operates, including the legal framework of its operation, the people required to send notifications to the system, the notification process and the main outputs from the system.
The protocols should include a list of notifiable diseases with, for each disease:

- the rationale for surveillance, linked to the aims of the surveillance system.
  (e.g. *Salmonella* is under surveillance because it is an outbreak-prone pathogen and one of the aims of the surveillance system is to detect outbreaks);
- the case definition;
- data analysis plans for monitoring trends and the thresholds used for cluster detection;
- public health action required (e.g. one case triggers a response or response launched when there is a cluster).

Figure 9 shows how the surveillance protocols fit with other supporting documentation for the surveillance and response system in stage 2. The documentation may be combined in one document or kept as separate documents.
Options for strengthening notifiable disease surveillance

Box 3 summarizes the options for strengthening the notifiable disease surveillance system in stage 2. This information is also given in the decision-tree for notifiable disease surveillance in Figure 10.
BOX 3.

Summary of options for strengthening notifiable disease surveillance

- Amend public health legislation and decrees to add priority laboratory-confirmed foodborne hazards to the national notifiable disease list.
- Write case definitions for each notifiable disease.
- Create notification forms and a reporting mechanism (e.g. fax number, telephone notification, web-based system).
- Ensure that laboratories and health care workers are aware of their obligation to report notifiable diseases.
- Expand the existing notifiable disease surveillance database to receive notifications about individual cases from health workers and laboratories.
- Ensure that there is a data dictionary to support the database.
- Regularly analyse data for trends and to identify vulnerable populations.
- Establish thresholds for the detection of clusters.
- Ensure that surveillance data are regularly reported in the surveillance bulletin.
- Update existing surveillance protocols to document the process of notification, the diseases under surveillance, the analyses being conducted and the public health action that should be taken for each disease.
- Document all changes to the notifiable disease surveillance system in a surveillance log.
- Establish a surveillance log for each disease.
## for strengthening notifiable disease surveillance for foodborne diseases in stage 2

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prioritizing foodborne diseases for surveillance</td>
<td>Annex 1</td>
</tr>
<tr>
<td>Minimum data requirements for the notifiable disease surveillance database</td>
<td>Annex 4</td>
</tr>
<tr>
<td>Example of a data dictionary</td>
<td>Annex 5</td>
</tr>
<tr>
<td>Example of a surveillance log</td>
<td>Annex 6</td>
</tr>
<tr>
<td>Review of cluster detection methods</td>
<td>Robertson et al., 2010</td>
</tr>
<tr>
<td>Steps for strengthening notifiable disease surveillance for foodborne diseases</td>
<td>Figure 10</td>
</tr>
</tbody>
</table>
FIGURE 10.
Decision-tree to identify the steps a country can take to strengthen notifiable disease surveillance for foodborne diseases in stage 2

1. Have the priorities for notifiable disease surveillance (including foodborne diseases) been established?
   - Yes
   - No

2. Has the legislation been amended to add priority foodborne diseases to the national notifiable disease list?
   - Yes
   - No

3. Are there standard surveillance case definitions for each foodborne disease?
   - Yes
   - No

4. Are laboratories reporting to the notifiable disease surveillance system?
   - Yes
   - No

5. Are health care workers reporting to the notifiable disease surveillance system?
   - Yes
   - No

6. Is the notifiable disease surveillance system database able to capture individual-level data from laboratories and health care workers?
   - Yes
   - No

7. Are notifiable disease surveillance data regularly analysed?
   - Yes
   - No

8. Are there thresholds for cluster detection?
   - Yes
   - No

9. Are data being regularly reported in the surveillance bulletin?
   - Yes
   - No

10. Are there surveillance protocols to document surveillance processes and public health actions?
    - Yes
    - No

11. Capacities for notifiable disease surveillance in stage 2 have been established
    - Yes
    - No
5. Event-based surveillance
For a fully functional event-based surveillance system that can detect foodborne events, countries will need to ensure the following:

- a 24-hour telephone hotline, fax or email to receive reports at a national level;
- sensitivity of EBS has been strengthened through training of people outside the health system (e.g. media, village leaders, etc.);
- active scanning of the media at the national and international levels for information about possible foodborne events.

In stage 2, a country is building on its existing EBS system to detect more foodborne events. Strengthening EBS for foodborne diseases will involve finding a balance between sensitivity (picking up all important foodborne events), specificity (ensuring that most of the events detected are actually foodborne) and sustainability (in terms of the financial and human resource costs involved in maintaining the system).

**Foodborne event detection: options to increase sensitivity**

Countries considering increasing sensitivity will need to ensure that they have the capacity to assess and respond to more events. Sensitivity can be improved by:

- increasing the number of reports coming from the local level to a central authority (passive surveillance); or
actively scanning radio, print and electronic media for information about possible foodborne events (active surveillance).

Table 4 presents several options for increasing the sensitivity of EBS. Improvements in sensitivity need to be balanced against the long-term sustainability of the overall surveillance and response system. For example, a 24-hour hotline could initially be made available to health care workers and local sanitary or food inspectors; as capacity increases, other reporting sources could be given access, such as pharmacists, journalists and the general public. In addition, any actions to increase the sensitivity of the EBS system should be done in consultation with all partners within the ministry of health. It is possible that events detected through EBS may be vaccine-preventable or require urgent intervention by other parts of the ministry of health.

**TABLE 4.**

**Options for increasing sensitivity of EBS in stage 2**

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Passive surveillance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reporting channels</strong></td>
<td>National coverage for EBS.</td>
<td>Cost of training staff across the health care system to report events.</td>
</tr>
<tr>
<td>Expand coverage of EBS within the health care system (if the current system has limited geographical scope)</td>
<td>National coverage for EBS.</td>
<td>Cost of training staff across the health care system to report events.</td>
</tr>
<tr>
<td>Institute 24-hour, 7 days per week coverage (if the current system is limited with regard to time coverage)</td>
<td>A responsible, trained officer is available to receive reports 24 hours a day.</td>
<td>Requires staffing 24 hours a day.</td>
</tr>
<tr>
<td>Institute a hotline Options:</td>
<td>A toll-free hotline will remove any cost barriers to reporting.</td>
<td>The cost of the toll-free number will need to be funded.</td>
</tr>
<tr>
<td>• Toll-free phone number</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Advantages and Disadvantages

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text and call back</td>
<td>Texting the health authorities about an event has a limited cost to the reporter.</td>
<td>There is a cost to the authorities to return the call. Authorities must call back immediately, requiring permanent staffing of the hotline.</td>
</tr>
<tr>
<td>VHF/HF radio</td>
<td>Good option in remote areas where mobile phone coverage is poor.</td>
<td>Requires reporters to have access to VHF/HF radio equipment.</td>
</tr>
<tr>
<td>Establish an email address or dedicated fax line</td>
<td>Having other forms of communication in addition to a hotline can make reporting more flexible.</td>
<td>Requires a reliable telecommunications system. Requires information technology support.</td>
</tr>
</tbody>
</table>

### Reporting Sources

<table>
<thead>
<tr>
<th>Method</th>
<th>Potential for high sensitivity and specificity. Pharmacists often see the first signs of an unexpected increase in cases of a particular illness. Ill people often go to a pharmacist for advice or over-the-counter medicines before they go to a medical practitioner.</th>
<th>Most pharmacists are private practitioners and it may be difficult to encourage them to report events. Would require a system with regular feedback and follow-up.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train media personnel to recognize and report events</td>
<td>Can detect events early. Journalists engaged in reporting health events can use their networks for detection. Can also assist in communication of accurate information during events.</td>
<td>Media generally report on newsworthiness and not necessarily on public health importance. Public health events may not be detected and reported on in countries with heavily restricted or controlled media. Potentially low specificity as reports might not be related to foodborne disease or public health.</td>
</tr>
<tr>
<td>Train community leaders and nongovernmental organizations to recognize and report events</td>
<td>Potential for high sensitivity.</td>
<td>Potential for low specificity as reports might not be related to foodborne disease or public health. May be reluctant to report issues that could have negative consequences for the community.</td>
</tr>
</tbody>
</table>
### 1. Active surveillance

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan radio, print, electronic and social media</td>
<td>Does not rely on passive reports alone. Can provide timely information on foodborne events.</td>
</tr>
</tbody>
</table>

Monitor the sale of antidiarrhoeal medication and oral rehydration salts at selected pharmacies | Can provide an early indication of an increase in diarrhoea in the community. | Requires regular calls or visits to pharmacies to obtain data. Covers a small geographical area served by the selected pharmacies. |

Adapted from WHO (2008b).

### Foodborne event detection: options to increase specificity

Diarrhoea can be caused by many different agents, some of which are foodborne, while others are waterborne or transmitted directly from person to person. Identifying the likely route of transmission will allow early interventions to be targeted effectively. It can be difficult to detect foodborne events early in stage 1, when the specificity of the system is generally low. However, in stage 2, there are ways to increase specificity (Box 4), some of which can be implemented at the same time as actions to increase sensitivity. For example, if a country chooses to increase the number of reporters by training additional health care workers, pharmacists, media personnel or community leaders, the training sessions should include modules on recognizing foodborne events (see the stage 1 module).
BOX 4.

Options for increasing specificity of EBS in detecting foodborne events

- Train reporting sources (e.g. health care workers, pharmacists, media personnel and community leaders) to recognize foodborne events:
  - raise awareness of how a foodborne event might manifest itself;
  - encourage sources to report rumours of diarrhoeal illness in a group of people with a common exposure (e.g. within a workplace or school or following a function, such as a wedding).

- Select pharmacy sites that can provide data about the sale of antidiarrhoeal medication and oral rehydration salts.

- If monitoring media at the national level, include specific searches for foodborne events, e.g. use “contaminated food” or “food poisoning” as search terms.

- Examine reports from food safety colleagues about any product recalls or results from food monitoring programmes that may indicate a potential foodborne event.

- Distribute INFOSAN alerts to rapid risk assessment teams and health care workers reporting to the EBS system to raise awareness about hazards and their potential distribution.
Figure 11 shows the decision-tree for strengthening the sensitivity and specificity of EBS to detect foodborne events in stage 2.

### Reference guide

**for strengthening EBS to detect foodborne events in stage 2**

<table>
<thead>
<tr>
<th>Reference</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A guide to establishing event-based surveillance</em> (WHO, 2008b)</td>
<td><a href="http://www.wpro.who.int/emerging_diseases/documents/docs/eventbasedsurv.pdf">http://www.wpro.who.int/emerging_diseases/documents/docs/eventbasedsurv.pdf</a></td>
</tr>
<tr>
<td>Options for increasing sensitivity of EBS system</td>
<td>Table 4</td>
</tr>
<tr>
<td>Steps for strengthening the EBS system</td>
<td>Figure 11</td>
</tr>
</tbody>
</table>
FIGURE 11.
Decision-tree to identify the steps a country can take to strengthen event-based surveillance for foodborne diseases in stage 2

Is there a 24-hour telephone hotline, fax or email to receive reports at a national level?

- **YES**
  - Have people outside of the health system been trained to recognize and report foodborne events?

- **NO**
  - Establish a 24-hour telephone hotline, fax line or email address to receive reports at the national level.

- **YES**
  - Is there active scanning of the media to detect events?

- **NO**
  - Consider training journalists, village leaders and others in the community who could become reporters to the EBS system.
  - Ensure the training includes examples of foodborne events.

- **YES**
  - Capacities for event-based surveillance in stage 2 have been established

  - **NO**
    - Designate a staff member to actively scan media for foodborne events.
6. Rapid risk assessment of foodborne events
To be able to undertake rapid risk assessment of foodborne disease events at the subnational level, countries will need to ensure the following:

- staff at the subnational level have been designated responsibility for conducting rapid risk assessments;
- these staff at the subnational level have been trained in rapid risk assessment and the training included examples of foodborne disease events that have occurred;
- a mechanism is in place that allows the national level to provide technical support and advice to the subnational level, as required;
- laboratory data are routinely used in the rapid risk assessment of foodborne disease events.

Most of the capacities for rapid risk assessment are developed while countries are in stage 1. Detailed guidance on strengthening rapid risk assessment is available elsewhere (ECDC, 2011; WHO, 2012). Table 5 summarizes how rapid risk assessment of foodborne disease events differs between stage 1 and stage 2. In stage 2, the capacities for rapid risk assessment at the subnational level should be strengthened. This involves:

- identifying staff who will be involved in rapid risk assessments;
- training the staff in the procedures that have been adopted nationally; the training should include examples of foodborne disease events that have occurred in the country and been assessed at the national level;
(setting up a mechanism through which technical support and advice can be provided from the national level to the subnational level, as required. In some countries, the mechanism may be as simple as a telephone call; other countries may require an official request for assistance.

The information used in the rapid risk assessment process is generally of a higher quality, more reliable and more complete in stage 2. Annex 7 contains an example of information that can be used in a rapid risk assessment in stage 2. In stage 1, there is more uncertainty in the risk characterization, as the risk assessment relies mainly on published data from other countries. As laboratory-based surveillance is strengthened, countries in stage 2 will be able to use their own detailed data to inform hazard, exposure and context assessments, thus increasing the confidence in the overall risk assessment. An example of risk characterization of a possible foodborne event is given in Annex 10 of the stage 1 module.

Multisectoral collaboration during rapid risk assessments is stronger in stage 2, with each of the different sectors being involved in assessing the risk posed by the event. In stage 2, food safety staff and public health laboratory staff should be permanent members of the rapid risk assessment teams for suspected foodborne events. The roles and responsibilities of each member of the rapid risk assessment team should be clear and documented, either in the surveillance or the response protocols.)
TABLE 5.
Comparison of rapid risk assessment of possible foodborne disease events in stage 1 and stage 2

<table>
<thead>
<tr>
<th></th>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of rapid risk assessment capacities</td>
<td>National level</td>
<td>National and subnational levels</td>
</tr>
<tr>
<td>Information for hazard, exposure and context assessments</td>
<td>• Limited • Reliant on published studies or data from other countries</td>
<td>• Extensive • Own country data</td>
</tr>
<tr>
<td>Multisectoral collaboration</td>
<td>Focal points from food safety and laboratory identified and participate in rapid risk assessments, as required</td>
<td>Food safety and laboratory staff are standing members of rapid risk assessment teams when an event is suspected to be foodborne</td>
</tr>
</tbody>
</table>

---

for strengthening rapid risk assessment of foodborne events in stage 2

- **Rapid risk assessment of acute public health events (WHO, 2012)**

- **Operational guidance on rapid risk assessment methodology (ECDC, 2011)**

- Examples of information used in the assessment of hazards, exposures and context in stage 2
  - Annex 7

- Example of risk characterization of a possible foodborne event
  - Stage 1 module, Annex 10
7.
Response
To have a subnational response capacity that can carry out analytical epidemiological studies during foodborne outbreak investigations, countries will need to ensure the following:

- specific questionnaires are available for each priority foodborne pathogen;
- capacity to conduct analytical epidemiological studies during outbreak investigations exists at the national and subnational levels;
- representatives from food safety and public health laboratories (and animal health, where applicable) are routinely part of the outbreak response team.

During stage 1, strengthening of response capacity focused on conducting descriptive epidemiological studies throughout the country, with capacity to perform analytical epidemiological studies at the national level. In stage 2, the focus is on building the capacity to carry out analytical epidemiological studies in outbreak response teams (ORTs) at the subnational level. This will require significant investments of resources and time. However, the availability of a cadre of trained field epidemiologists will benefit not only foodborne diseases, but the whole surveillance and response system. Table 6 shows how response differs between stage 1 and stage 2.
TABLE 6.
Comparison of response to possible foodborne disease events in stage 1 and stage 2

<table>
<thead>
<tr>
<th></th>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of capacities to perform analytical epidemiological studies</td>
<td>May be only one or two epidemiologists in the country who can be mobilized to assist</td>
<td>National and subnational levels</td>
</tr>
<tr>
<td>Questionnaires</td>
<td>General; one questionnaire can be used for any type of investigation</td>
<td>Specific questionnaires for each priority foodborne pathogen</td>
</tr>
<tr>
<td>Multisectoral collaboration</td>
<td>Focal points from food safety and laboratories identified and participate in responses</td>
<td>Representatives from food safety and laboratories (and animal health, where applicable) are routinely part of the outbreak response team</td>
</tr>
</tbody>
</table>

Building capacity in analytical epidemiology

One of the main differences in response between stage 1 and stage 2 is the strengthening of skills in analytical epidemiology at the subnational level. This will involve identifying motivated staff at the subnational level and offering opportunities for these staff to receive training in field epidemiology. To perform analytical epidemiological studies during foodborne outbreak investigations, staff need to be able to:

- ✓ generate hypotheses about specific food sources on the basis of food history questionnaires;
- ✓ choose the correct study design (cohort study vs case–control study);
- ✓ design questionnaires to test hypotheses about the food source (i.e. include specific food items thought to be responsible for the illness);
- ✓ administer the questionnaires;
Stage two

- create a database to store responses from the questionnaires;
- enter data into the database;
- manage and clean the data in the database;
- extract the data from the database;
- analyse the data using univariate and multivariate analyses;
- evaluate the effect of bias and confounding on the results of the analysis;
- communicate the findings from the analysis.

Building capacities in epidemiology is a long-term process and can be achieved in a number of ways, including:

- training members of the ORTs in outbreak investigation techniques, including analytical epidemiology;
- mentoring enthusiastic staff in the field during outbreak investigations;
- providing formal training in the Master of Public Health degree programme;
- providing formal training in a field epidemiology training programme (FETP) or a modified FETP (e.g. a six-month programme that teaches basic field epidemiology).
There are several different models of FETP, and most are built on a learning-by-doing approach, first established by the US CDC for the training of epidemic intelligence service officers (Jones et al., 2014). The students learn while they are in field placements, and it is important that they have mentors to guide them. Each FETP specifies core competencies that the students must meet. One of the key competencies is the ability to conduct outbreak investigations, specifically to carry out analytical epidemiological studies. Case study 5 describes how countries in Central America established sustainable FETPs.

CASE STUDY 5.

Approach to field epidemiology training in Central America

After two hurricanes devastated the Central American region in 1998, there was a need to strengthen the response to public health emergencies. A regional FETP was established, based on a three-tiered model.

- **First tier.** Local health workers were trained in basic epidemiology to enable them to respond to local events. Training was conducted over a 3–5 month period.

- **Intermediate tier.** A nine-month training programme built on the competencies acquired in the first tier.

- **Advanced tier.** A two-year FETP was established, leading to an academic qualification from a university.

All three tiers included some formal training in a classroom, but most of the competencies were gained during field work at the students’ workplaces. As the capacities in field epidemiology increased in the region, individual countries built their own FETPs. Five important considerations for ensuring a sustainable FETP were:
Incorporating methods used in foodborne disease outbreak investigations into the training curriculum of existing field epidemiology training programmes in a country is the ideal way to ensure that the epidemiologists are trained to conduct analytical epidemiological studies. Being able to conduct a cohort or case–control study is one of the main capacities required in the response to foodborne disease outbreaks. Examples of case–control and cohort studies are given elsewhere (WHO, 2008a).

**Questionnaires**

Countries in stage 2 should have specific questionnaires for each foodborne pathogen under surveillance. Many diseases are associated with specific exposures, which will need to be explored in detail, e.g. reef fish for ciguatera intoxication and sweet cassava for cyanide poisoning. Web links to some examples of disease-specific questionnaires are given in Table 7.
Eggs have been identified as a high-risk food item for salmonellosis. A Salmonella questionnaire may, therefore, include a detailed section on eggs, including questions about:

- the type of egg (e.g. chicken, duck);
- how it was produced (e.g. free-range, caged, barn-laid);
- the brand of the egg;
- the place where the egg was purchased;
- any other information that may assist in tracing the eggs consumed back to the farm that produced them (e.g. batch numbers, use-by dates, etc.).

There are two approaches to obtaining a food history through a questionnaire.

1. **Open-ended food history.** The interviewer asks the patients what they ate for breakfast, lunch, dinner, etc. on each day in the incubation period. This method is useful for identifying novel food sources. However, the quality of the information obtained may not be high, because of recall bias. Often, 1–2 weeks may have passed between the time a specimen is collected and the time of the interview, and the patient may not remember the exact details of all the food consumed during the incubation period.

2. **Trawling questionnaire.** The interviewer asks the patients whether they ate a specific food item. The list of foods that may have been contaminated with the agent should be based on previous experience and information published in the literature. This approach can be helpful for foods commonly found to be a source of infection, but may not be useful for identifying novel food sources.
It is often best to use a combination of open-ended food history and a section with trawling questions. For guidance related to questionnaire development, please refer to WHO (2008a).

**TABLE 7.**

**Web links to disease-specific questionnaires**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Country</th>
<th>Web link to questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Listeria</em> infection</td>
<td>USA</td>
<td><a href="http://www.cdc.gov/nationalsurveillance/PDFs/ListeriaCaseReportFormOMB0920-0004_alfalfa.pdf">http://www.cdc.gov/nationalsurveillance/PDFs/ListeriaCaseReportFormOMB0920-0004_alfalfa.pdf</a></td>
</tr>
</tbody>
</table>

**Multisectoral collaboration**

Multisectoral collaboration becomes truly operational during stage 2. The epidemiological aspects of outbreak investigations will be led by the surveillance and response sector, but the overall response to the outbreak will involve food safety and animal health staff, who have the mandate to implement many of the possible control measures.

The key information from an epidemiological investigation required by food safety colleagues is the possible food source, plus any information that would enable them to conduct a trace-back to determine exactly where control measures need to be targeted. In a large proportion of foodborne outbreaks, the source can be identified with detailed descriptive epidemiology and trace-back investigations.
Even when a food item has been incriminated by analytical studies, trace-back is still necessary to identify the exact source and allow appropriate control measures to be taken. The epidemiological investigation should obtain as much detail as possible about the suspected food source, through, for example, detailed food history interviews and examining food purchases by checking receipts or data from loyalty card schemes.

Reference guide

**for strengthening the response to foodborne disease events in stage 2**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>GuiaVETA: guidelines of surveillance systems for foodborne diseases and investigation of outbreaks</td>
<td>INPPAZ, PAHO, WHO (2001)</td>
</tr>
<tr>
<td>Examples of disease-specific questionnaires</td>
<td>Table 7</td>
</tr>
</tbody>
</table>
8.

Ad hoc research studies: supplementing surveillance and response data
To undertake ad hoc research studies to attribute food sources to specific diseases, understand foodborne disease epidemiology and estimate the burden of foodborne diseases in the community, countries will need to develop or strengthen:

- a mechanism for discussing, agreeing, planning and undertaking ad hoc research studies.

There may be occasions when the existing surveillance system cannot answer some important questions in relation to foodborne diseases, such as the following.

- What proportion of diarrhoeal illness in community X is caused by pathogens that might be foodborne?

- We see outbreaks of a particular type of *Salmonella*, but our surveillance system tells us there are sporadic cases too. Is the food item responsible for the outbreaks also causing the sporadic cases?

- What proportion of Shiga-toxin-producing *E. coli* (STEC) cases reported to the surveillance system are foodborne?

- Do the types of *Campylobacter* found in humans also occur in foods or in animals? What proportion of *Campylobacter* cases reported to the surveillance system may be attributed to chicken meat?
Ad hoc research studies can answer some of these questions. Several types of studies are described below, and the advantages and disadvantages of each study type are shown in Table 8. Some studies, such as risk factor studies, use methods that could apply to any disease, such as case–control studies; other types of studies, such as source attribution studies, are specific to foodborne illness.

Etiological studies

Early in stage 2, it may be necessary to consider some targeted public health studies to answer questions about the incidence of different foodborne pathogens causing disease in the community. Results from these studies can provide an indication of the diversity of such pathogens and identify the main ones. These results can be used in drawing up the priority list of pathogens for surveillance and help guide laboratory strengthening activities. For example, if *Salmonella* was the most frequently isolated organism from a sample of people presenting with diarrhoea in a community, it may be worth while to strengthen laboratory capacity for *Salmonella* testing. Etiological studies can also be useful in identifying high-risk groups. For example, enterohaemorrhagic *E.coli* may be more frequently isolated from children, indicating that the burden of illness may be higher in this group. To determine if a specific age-group is at higher risk, it would be necessary to know the total number of cases reported and also the underlying demographic profile in the area. Once high-risk groups have been identified, possible sources of the illness can be examined and appropriate groups targeted with interventions. Examples of etiological studies are given in case studies 6 and 7.
CASE STUDY 6.
Etiology of persistent diarrhoea in young children in rural northern India

A cohort study followed 963 children aged 0–71 months for 12 months. The incidence of persistent diarrhoea was 6.3 per 100 child–years and was highest in those aged 0–11 months. Pathogens isolated during persistent episodes of diarrhoea included enterotoxigenic Escherichia coli (9.3%), Salmonella spp. (4.7%), Campylobacter (4.7%), Shigella spp. (2.3%), Entamoeba histolytica (2.3%), and rotavirus (2.3%). Similar proportions of these pathogens were also isolated during episodes of acute diarrhoea.

Source: Bhan et al., 1989.

CASE STUDY 7.
Salmonellosis in Guangdong province, China

A total of 42,889 specimens were collected from people who presented to outpatient clinics at 15 hospitals in Guangdong, China, from 2007 to 2012. All the samples were tested for Salmonella and those that were positive were further characterized using antigen and PFGE testing. The antimicrobial susceptibility of the isolates was also tested. Of the specimens collected, 1,764 were positive for Salmonella, and the most common serovars were Typhimurium (n=523), Enteritidis (n=257) and 4,5,12:i:– (n=244). The research team was able to demonstrate that the burden of Salmonella Typhimurium and Salmonella 4, 5, 12:i:– was highest in infants, while Salmonella Enteritidis was more frequently isolated from adults. There was a high level of multidrug resistance, with 1,128 samples exhibiting resistance to more than one of the agents tested. Only 9.97% (n=176) of isolates were fully susceptible.

Source: Ke et al., 2014.
Risk factor studies

During an outbreak investigation, analytical or laboratory evidence will often implicate a high-risk food item as responsible for foodborne illness. With some of the more common endemic *Salmonella* serovars, a large number of cases may be reported to the surveillance system that are not part of a point source outbreak. To understand the risk factors for sporadic illness in a community, a case–control study is needed. Cases reported through the surveillance system are interviewed using a specific questionnaire. Controls are recruited and asked the same questions. Analysis of the results can identify the food items associated with sporadic illness in the community (case study 8). The three main issues to consider in designing a case–control study to examine risk factors for sporadic infection with foodborne pathogens are: the case definition, selection of controls and assessment of exposures (Fullerton et al., 2012).

Once the case–control study has been completed and the food items associated with infection have been identified, control measures aimed at reducing illness in humans should be discussed with food safety colleagues, veterinarians from the agricultural sector and the relevant industry.

**CASE STUDY 8.**

Risk factors for sporadic *Salmonella Enteritidis* infections in the United States of America

A case–control study was undertaken with 182 cases of *Salmonella Enteritidis* infection and 345 controls. Illness was significantly associated with: international travel (matched odds ratio (mOR), 61, 95% confidence interval (CI), 8–447); eating undercooked eggs (mOR, 2.2, 95% CI, 1–5); and eating chicken prepared outside of the home (mOR, 2.2, 95% CI, 1.3–3.4). Eating chicken outside of the home remained the only significant risk factor for illness (mOR, 2.0, 95% CI, 1.1–3.6) in a multivariate analysis.

Source: Kimura et al., 2004.
**Burden of disease studies**

Surveillance systems often do not capture all the illness occurring in the community. This is especially the case with diarrhoeal illness, as people may not seek health care. Burden of foodborne disease studies are required to estimate the true burden of gastroenteritis in the community and assign the proportion that is thought to be foodborne. Once the total burden of acute gastroenteritis is known, food-specific and pathogen-specific estimates can be determined. Burden of disease studies are useful for policy-setting by governments. If food-specific burdens can be estimated, the results can guide interventions and provide an evidence base for decision-making about where funds for interventions could be targeted. Case study 9 describes the estimation of the burden of gastroenteritis in Argentina.

Guidance on methods for estimating the burden of disease is given elsewhere (WHO, 2015). Countries requiring further guidance are invited to contact the WHO Department of Food Safety and Zoonoses (foodsafety@who.int).

**CASE STUDY 9.**

**Burden of gastrointestinal illness in Argentina**

A study to estimate the burden of acute gastrointestinal illness (GI) was conducted in Galvez, Argentina, in 2007. Respondents were asked if they had experienced GI in the previous 7 days or 30 days. The data collection period was split between the low GI season and the high GI season, to examine the impact of seasonality on the burden of GI. A total of 2915 people were surveyed. The mean annual incidence using the 30-day recall period was 0.43 (low GI season) and 0.49 (high GI season) episodes per person–year. In comparison, the mean annual incidence given by the 7-day recall period was 0.76 (low GI season) and 2.66 (high GI season) episodes per person–year. In a multivariate model, the risk factors associated with acute GI in Galvez were high GI season, younger age group and neighbourhood.

Source: Thomas et al., 2010.
Source attribution studies

Pathogens transmitted by food may have more than one source and may also be spread via other routes of transmission (e.g. animal-to-person or person-to-person). It is therefore important to understand, for each pathogen, the proportion of human illness that is caused by a food vehicle. Source attribution studies are used to determine what proportion of illness can be attributed to particular food sources. There are various approaches to attributing foodborne illness to specific food sources (EFSA, 2008). The main approaches are described below.

1. **Microbial subtyping.** This involves testing human, animal or food samples using highly discriminatory laboratory methods, such as multilocus sequence typing (MLST) or PFGE. The laboratory results from each sector are then compared to determine where there are overlaps and hence identify a potential source of the illness in humans. An example of a source attribution study using this approach is given in case study 10.

2. **Summary outbreak data.** Outbreak surveillance data are compiled and statistical models are applied. Food sources identified during outbreak investigations can thus be attributed to specific pathogens (case study 11).

3. **Epidemiological studies of sporadic cases.** These involve interviewing sporadic cases for their food histories and determining the likely source through a case-series investigation. The epidemiology-based approach can also use case-control methods and may involve further analysis to calculate a population attributable fraction (Stafford et al., 2008), which gives an estimate of the proportion of cases attributable to a food vehicle.
4. **Risk assessments.** These involve quantifying the exposure to pathogens from a multitude of sources using risk assessment methods.

5. **Expert opinion.** A group of experts discusses gaps in the data and estimates the proportion of illness attributable to specific food items. The Delphi method may be used to obtain consensus or structured elicitation methods can be used to calculate an estimate of illness attributable to a specific food source. For example, the WHO global burden of disease estimates used Cooke’s classical model, in which responses to seed questions are used to weight and aggregate expert responses to questions about food attribution.

These methods are discussed in detail elsewhere (EFSA, 2008; Pires et al., 2009; Hald et al., 2016), together with the advantages, disadvantages and data requirements of each approach.

The outcomes from source attribution studies provide an evidence base for specific pathogen–food pairs. It will then be possible to work with food safety colleagues, veterinarians from the agricultural sector, and the relevant industry to focus control measures. Source attribution studies can also be used to evaluate the effectiveness of interventions.
CASE STUDY 10.

*Campylobacter* source attribution using laboratory methods in Scotland

*Campylobacter* isolates from humans (5674 cases) were compared with 3419 non-human isolates collected in Scotland in 2005–06. Multilocus sequence typing was performed on all the isolates and the results were analysed using statistical models. The models attributed 76% of clinical isolates to chicken and 20% to cattle and sheep. Only about 4% of isolates were attributed to wild birds, the environment, swine, and turkey.

Source: Sheppard et al., 2009.

CASE STUDY 11.

Source attribution in Latin America and the Caribbean using data from outbreak investigations

Source attribution was done using outbreak surveillance data from countries in Latin America and the Caribbean. A statistical model was developed for the main foodborne bacterial pathogens. Between 1993 and 2010, there were 6313 outbreaks reported across 20 countries. From 1993 to 1999, the most important sources of bacterial pathogens in outbreaks were meat, dairy products, water and vegetables. From 2000 to 2010, eggs, vegetables and grains and beans were the most important sources of bacterial outbreaks. This study identified gaps in surveillance data, but the approach was found to be useful for developing countries where surveillance for foodborne diseases may be limited.

Source: Pires et al., 2012.
Pathogen prevalence along the food chain

As a step towards stage 3, a country may consider conducting a survey to measure pathogen prevalence at each step along the food chain, from the farm, through the various processing steps, distribution and retail outlets. The findings can be compared with human surveillance data to determine if there are any overlaps in the types of pathogens present (case study 12).

CASE STUDY 12.

Pathogen prevalence along the food chain in Mexico

Four states in Mexico conducted a study to examine the prevalence of *Salmonella* spp. across the food chain from March 2002 to August 2005. Samples were collected at three different points along the food chain: (1) ill and asymptomatic children; (2) pork, chicken and beef on sale in the retail sector; and (3) intestines from chicken, swine and cattle at slaughter houses. The *Salmonella* isolates were tested for antimicrobial resistance and were further typed by PFGE. The main findings were:

- high rates of contamination of meat (21.3–36.4%);
- high rates of ceftriaxone-resistant *S. Typhimurium* in chicken (77.3% of all *S. Typhimurium* isolates), ill humans (66.3%), and swine (40.4%);
- the emergence of ciprofloxacin resistance in *S. Heidelberg* (10.4%) and *S. Typhimurium* (1.7%) from swine.

Source: Zaidi et al., 2008.
Studies to identify foodborne chemical hazards

Chemical hazards cannot be monitored through the surveillance system for communicable diseases. The main concern with chemical hazards is their long-term health effects. Food monitoring will have an important role in regularly sampling food items, testing them for priority chemical hazards and assessing the levels of contaminants in food in relation to maximum allowable limits.

WHO has published guidance on assessing dietary exposure to chemicals in foods (WHO, 2009). These assessments require data on the concentrations of chemicals in foods and on consumption of specific food items. Total diet studies are the most robust for estimating the concentrations of chemicals in foods (EFSA, FAO, WHO, 2011). Food consumption data can be obtained from food diaries and recall of foods eaten in the previous 24 hours. Foods are then purchased, prepared (cooked, peeled, etc.) and pooled into groups. The pooled food groups are then sampled and analysed for priority chemical hazards. Data from total diet studies and food histories can be put into risk-based models and the dietary exposure calculated. This is then compared with maximum allowable limits for the chemicals of interest to determine the health risks to the community.

Where to begin

When a country identifies a gap in knowledge about foodborne diseases that the surveillance and response system cannot answer, it may be necessary to consider conducting one of the ad hoc studies discussed above. There are many ways to approach such a study, but a general outline of the process is given below.
FORM A WORKING GROUP
Bring together people with relevant expertise to discuss the study question. Terms of reference should be established for the working group, to allow it to focus on the study.

IDENTIFY EXPERTS TO PARTICIPATE IN THE STUDY
Key experts in the country should participate in the study. These experts do not need to possess all the skills to conduct the study, but should be familiar with research methods, foodborne diseases and the context in which the study will be undertaken. Experts should include government staff and academics from the university sector, as a minimum. A lead investigator should be identified.

IDENTIFY THE APPROPRIATE METHODS
The working group will need to decide on the most appropriate method for answering the study question. The sections above provide some ideas as a starting-point.

IDENTIFY FUNDING
Some ad hoc studies are expensive and will require significant resources. The financial and human resources required for the study should be identified before the study begins.

ETHICAL CONSIDERATIONS
Some studies may require prior approval from a human research ethics committee.

OUTCOMES FROM THE STUDY
Given that ad hoc studies are undertaken to answer specific questions, the outcomes from the study should be anticipated. For example, is the study likely to lead to a policy change in relation to food safety or regulation? If so, food safety experts will need to be part of the working group to ensure that the outcomes can be used to influence policy change.
### TABLE 8.
Types of ad hoc research studies that can be useful for foodborne diseases

<table>
<thead>
<tr>
<th>Type of ad hoc research study</th>
<th>Requirements for the study</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Etiological study            | • research question coming from gaps in surveillance data (e.g. what are the main microbial pathogens causing diarrhoea in the community?)  
• Laboratories can identify pathogens                                                                 | • Can be relatively inexpensive, depending on the pathogens being tested  
• Uses a sentinel surveillance approach, which can be a foundation for routine sentinel surveillance in the future | • Only measures one point in time  
• Considerations of bias and the ability to generalize results to whole country |
| Risk factor study            | • Laboratories can identify pathogens  
• Cases need to be interviewed by public health authorities  
• Analytical epidemiology skills (e.g. case–control study analysis)                                                                 | • Useful for identifying risk factors for sporadic infections | • Can be time-consuming  
• Careful consideration of study design (e.g. selection of controls) |
| Burden of disease study      | • Laboratories can identify pathogens  
• Population-based cross-sectional study design  
• Statistical assistance                                                                 | • Provides an accurate estimate of gastroenteritis in the community  
• Provides an estimate of the proportion of gastroenteritis that is likely to be foodborne | • Requires significant resources |
| Source attribution study     | • For the laboratory-based approach, laboratories can identify and characterize pathogens to the highest level  
• For the epidemiological approach, comprehensive and complete outbreak surveillance data  
• Statistical assistance  
• Cooperation with colleagues in food safety and agriculture | • Can attribute food sources to specific foodborne pathogens  
• Epidemiological approach can be used in developing countries where the laboratory approach may not be appropriate  
• Can foster multisectoral collaboration | • Discriminatory laboratory tests can be expensive  
• If using outbreak surveillance data, the attribution would only be in an outbreak setting and may not be generalizable to sporadic illness  
• Need a large number of samples to ensure adequate power in study |
| Prevalence along the food chain | • Laboratories dealing with different sectors (human, animal and food) can identify pathogens and use mutually agreed subtyping methods  
• Cooperation with colleagues in food safety and agriculture | • Identify food sources responsible for human illness  
• Can foster multisectoral collaboration  
• Useful first step towards integrated food chain surveillance | • Only measures one point in time and cannot provide ongoing information about food sources |
(TABLE 8. Continue)

<table>
<thead>
<tr>
<th>Type of ad hoc research study</th>
<th>Requirements for the study</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Total diet study (TDS)       | • Laboratories that can test for priority chemical hazards in foods                         | • Can identify chemical hazards in specific food groups  
• Data from TDS can be triangulated with food consumption surveys to assess dietary exposure to chemicals | • Can be expensive, as need a large sample size and range of foods for analysis  
• May only be able to measure a small number of chemical hazards                                                                                   |
| Food consumption studies     | • Population-based cross-sectional survey design                                             | • Provides an excellent snapshot of the food consumed by the general population  
• Data generated can also be used in assessing food histories obtained during cluster investigations | • Need a large number of participants to ensure adequate power in study  
• Often need to run over long period of time to account for seasonality in foods consumed                                                                     |

---

**for ad hoc research studies on foodborne diseases in stage 2**

<table>
<thead>
<tr>
<th>Advantages and disadvantages of different ad hoc study designs</th>
<th>Table 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burden of foodborne disease method</td>
<td>Under development (Foodborne Disease Burden Epidemiology Reference Group) <a href="http://www.who.int/foodsafety/areas_work/foodborne-diseases/ferg/en/">http://www.who.int/foodsafety/areas_work/foodborne-diseases/ferg/en/</a></td>
</tr>
<tr>
<td>World Health Organization estimates of the relative contributions of food to the burden of disease due to selected foodborne hazards: a structured expert elicitation (Hald et al., 2016)</td>
<td><a href="http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0145839">http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0145839</a></td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------</td>
</tr>
</tbody>
</table>
9. Multisectoral collaboration
For multisectoral collaboration that facilitates the sharing of data for risk profiling, countries will need to develop or strengthen the following:

- a functioning communication mechanism between all stakeholders in food safety in the country; this requires agreement on:
  - what information is to be shared,
  - when information needs to be shared,
  - who needs to know the information, and
  - how information is to be shared;
- evidence that this mechanism is in operation, e.g. a written communications plan, report from an outbreak debriefing about how the teams will work together better, etc.;
- multisectoral involvement in risk profiling of food safety problems, to help identify appropriate risk management strategies.

Multisectoral collaboration becomes increasingly important in stage 2. There will be operational linkages during the response to acute public health events. However, there will also need to be strategic linkages, to ensure that surveillance data from humans can be combined with food monitoring data to improve understanding of some of the risks posed by hazards in food items.
Establishing mechanisms for collaboration

The food safety and monitoring systems will be developing in parallel with the surveillance and response system. It will be important to ensure the cooperation of all stakeholders and that coordination and communication mechanisms are established (WHO, FAO, OIE, 2008). Some of the questions that need to be addressed when creating a communication mechanism are:

- What information is to be shared?
- When does the information need to be shared?
- Who needs to know the information?
- How is the information to be shared?

Table 9 suggests some possible answers to these questions, which can form the basis of a communication mechanism. A template for a communication mechanism between surveillance and response staff and food safety staff is given in Annex 8. It may be possible to establish a working group that specifically addresses multisectoral collaboration for foodborne diseases. Representatives on the working group could include disease surveillance and response staff, food safety staff, veterinarians from the agricultural sector, horticulturalists, toxicologists, laboratory personnel and people responsible for monitoring of food for export. Clear terms of reference need to be drawn up and the mandates of each partner clearly identified and respected. Figure 12 shows the steps a country can take to strengthen multisectoral collaboration in stage 2.
### TABLE 9.

**An example of a basis for a communication mechanism**

<table>
<thead>
<tr>
<th>Question</th>
<th>Acute events</th>
<th>Routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>What information needs to be shared?</td>
<td>• Event details from the initial report: how many are ill, where they are</td>
<td>• Surveillance bulletins</td>
</tr>
<tr>
<td></td>
<td>located, dates of onset of illness, suspected sources of illness</td>
<td>• Specific data for understanding the risks for certain pathogens</td>
</tr>
<tr>
<td></td>
<td>• Detailed information from case interviews, such as date of illness onset,</td>
<td>• Results from food monitoring</td>
</tr>
<tr>
<td></td>
<td>brand and place of purchase of suspected food source to assist in</td>
<td>• Information about preventative measures being implemented across</td>
</tr>
<tr>
<td></td>
<td>trace-back.</td>
<td>the food chain</td>
</tr>
<tr>
<td>When does the information need to be shared?</td>
<td>Within 24 hours of the first report of an event and updated daily at</td>
<td>Whenever new surveillance bulletins are issued</td>
</tr>
<tr>
<td></td>
<td>outbreak meetings</td>
<td>Whenever reports from food monitoring are issued</td>
</tr>
<tr>
<td>Who needs to know the information?</td>
<td>Designated food safety focal points for events</td>
<td>Food safety team</td>
</tr>
<tr>
<td></td>
<td>Designated surveillance and response focal points for events</td>
<td>Surveillance and response team</td>
</tr>
<tr>
<td>How is the information to be shared?</td>
<td>Email, telephone, minutes of outbreak meetings</td>
<td>Email surveillance bulletins and food monitoring reports</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Present results to partners</td>
</tr>
</tbody>
</table>
FIGURE 12.

Decision-tree to identify the steps a country can take to strengthen multisectoral collaboration for foodborne diseases in stage 2

Risk profiling

As the surveillance and response system for foodborne diseases is strengthened, countries will be able to use the surveillance data to contribute to risk profiling. The risk profiles are generated by food regulators who have the mandate to take public health actions and interventions.

Risk profiling is the process of describing a food safety problem and its context to help identify opportunities for authorities to implement appropriate risk management strategies (FAO, WHO, 2006). A typical risk profile includes a brief description of (FAO, WHO, 2006):
the situation, product or commodity involved;

- the pathways by which consumers are exposed to the hazard;

- possible risks associated with that exposure;

- consumer perceptions of the risks;

- the distribution of possible risks among different segments of the population.

Table 10 lists the information that is included in a risk profile and shows where data from the surveillance and response system for foodborne diseases may be used.

Within the food safety sector, the risk profile assists risk managers in setting priorities, establishing if there are data gaps and deciding if a risk assessment is required. In many instances, the risk profile can be a preliminary risk assessment that summarizes all of the available information (FAO, WHO, 2006). Examples of a range of different risk profiles can be found on the website of the New Zealand Food Safety Authority (http://www.foodsafety.govt.nz/science-risk/risk-assessment/risk-profiles/).
# TABLE 10.

**Information included in a risk profile and role of data from the surveillance and response system**

<table>
<thead>
<tr>
<th>Information included in a risk profile</th>
<th>Data from surveillance and response system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial statement of the food safety issue</td>
<td>Might include a brief summary of the epidemiology in humans, from data in the notifiable disease surveillance system and event database. For example: “There were 850 cases of salmonellosis in humans in 2014 and 10 Salmonella outbreaks reported.”</td>
</tr>
<tr>
<td>Description of the hazard and foods involved</td>
<td>N/A</td>
</tr>
<tr>
<td>How and where the hazard enters the food supply</td>
<td>Some systems can capture data on the place where the food item was consumed (e.g. home, restaurant) and where the breakdown occurred that led to the outbreak (e.g. primary production, processing, distribution, domestic handling).</td>
</tr>
<tr>
<td>Which foods expose consumers to the hazard and how much of those foods are consumed by various groups in the population</td>
<td>Might include a summary of outbreaks linked to the specific food item that have been investigated and recorded in the event database.</td>
</tr>
<tr>
<td>Frequency, distribution and levels of occurrence of the hazard in foods</td>
<td>Source attribution studies can use data from the surveillance and response system to provide this information.</td>
</tr>
<tr>
<td>Possible risks identified from the available scientific literature</td>
<td>It is also possible to include this information from the event database if the following data on outbreaks are systematically collected: - contamination risk factors (e.g. raw products contaminated by animal or environmental pathogens, cross-contamination with raw animal ingredients); - factors in survival or improper treatment to inactivate bacteria (e.g. insufficient time/temperature, inadequate acidification) - factors that permit proliferation (e.g. inadequate hot or cold storage, slow cooling).</td>
</tr>
<tr>
<td>Nature of values at risk (human health, economic, cultural, etc.)</td>
<td>Description of the adverse human health effects: - detailed description of the epidemiology of the pathogen from the notifiable disease surveillance system;</td>
</tr>
</tbody>
</table>
Information included in a risk profile | Data from surveillance and response system
--- | ---
| • detailed summary of all outbreaks related to the pathogen and food item from the event database; • results from ad hoc research studies, such as risk factors identified from case–control studies of sporadic cases or information from source attribution studies. | Identification of high-risk groups in the population from the surveillance and outbreak data.

Distribution of the risk (who produces, benefits from, and bears the risk) | N/A

Characteristics of the commodity or hazard that might affect the availability and feasibility of risk management options | N/A

Current risk management practices relevant to the issue, including any regulatory standards | N/A

Public perceptions of the possible risks | N/A

Information about possible risk management (control) measures | N/A

Preliminary indication of questions that a risk assessment could (and could not) be expected to answer | N/A

Implications of risk management in terms of international agreements | N/A

Adapted from Box 2.5 in FAO, WHO, 2006.
N/A= not applicable
**Reference guide**

## for strengthening multisectoral collaboration in stage 2

<table>
<thead>
<tr>
<th>Steps to strengthen multisectoral collaboration</th>
<th>Figure 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template for a communication mechanism between surveillance and response staff and food safety staff</td>
<td>Annex 8</td>
</tr>
</tbody>
</table>
10. Monitoring and evaluation
For monitoring and evaluation of the surveillance and response system for foodborne diseases, countries will need to:

- revise monitoring indicators for each component of the system to include:
  - laboratory-confirmed foodborne diseases for IBS,
  - sensitivity and specificity of EBS,
  - subnational capacity for rapid risk assessment and response,
  - multisectoral collaboration;
- ensure regular evaluation of the surveillance and response system in relation to foodborne diseases.

Routine monitoring and regular evaluations can help to ensure that the surveillance and response system for foodborne diseases is functioning efficiently and effectively. Each component (EBS, IBS, rapid risk assessment, response and multisectoral collaboration) in the system should be monitored in stage 1. In stage 2, the indicators will need to be updated, as the surveillance and response system for foodborne diseases develops.

Guidance on monitoring and evaluation of disease surveillance and response systems has been published by WHO (2006a). This proposes indicators for monitoring and evaluation and contains tools for compiling data for monitoring purposes. Specific guidance on evaluation and monitoring of the early warning function of EBS and IBS is also available (WHO, 2014).
Monitoring

The generic monitoring indicators in the two guidance documents mentioned above also apply to foodborne diseases. However, a country may choose to add some indicators that specifically address foodborne diseases in stage 2 (Annex 9). The indicators used for monitoring each component in stage 1 will need to be reviewed to ensure that the most appropriate indicators are being used in stage 2. For example, for IBS, it will be important to include indicators of timeliness and completeness of data in notifications from laboratories.

Evaluation

If an evaluation of the national surveillance system is planned, a specific section on foodborne diseases and foodborne events could be included. This is an ideal opportunity to use existing resources to identify the ability of the broader disease surveillance and response system to address foodborne diseases, and to harness opportunities for funding foodborne disease surveillance that will also strengthen the broader system. The surveillance system attributes that are important for foodborne diseases are shown in Box 5.

**Box 5.**

*Desirable surveillance system attributes for foodborne diseases*

**Simplicity.**

The system should be as simple as possible to ensure that participants, such as notifiers (EBS and IBS), can contribute easily. The surveillance system database should also be kept simple at all stages, to ensure that data can be entered and extracted easily.
Flexibility.  
The system needs to be flexible, so that new syndromes or diseases can be added as the surveillance system moves from stage 1 to stage 2.

Data quality.  
The data should be complete and valid, regardless of the stage. As the surveillance system develops and more data are collected, it will be important to ensure that data quality is maintained.

Acceptability.  
The system needs to be acceptable to surveillance staff at the local level, to ensure that they send data regularly and on time.

Sensitivity.  
While the system does not need to detect every case occurring in a community, it needs to be sufficiently sensitive to detect events. Assessing sensitivity will also help determine the proportion of cases that are being reported to the surveillance system.

Positive predictive value.  
This should be quite high for the detection of events, so that responses are launched only for real events. The processes of event verification and rapid risk assessment are vital.

Representativeness.  
As the surveillance system develops, it should become more representative, to allow accurate monitoring of trends over time and evaluation of interventions.

Timeliness.  
This is the most important attribute for the detection of foodborne events, including outbreaks. As part of the evaluation, it will be important to examine where delays are possible throughout the surveillance system.
**Stability.**
The system should be sufficiently stable to allow the data being reported to be regularly assessed. It is important to have a stable baseline to determine whether observations are above what is expected.

Based on guidance from the Centers for Disease Control and Prevention (2001) and WHO (2014).

---

**for strengthening monitoring and evaluation of the surveillance and response system in stage 2**

<table>
<thead>
<tr>
<th>Reference guide</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communicable disease surveillance and response systems: guide to monitoring and evaluating</strong> (WHO, 2006a)</td>
</tr>
<tr>
<td><strong>Early detection, assessment and response to acute public health events: implementation of early warning and response with a focus on event-based surveillance. Interim version</strong> (WHO, 2014)</td>
</tr>
<tr>
<td><strong>Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group</strong> (Centers for Disease Control and Prevention, 2001)</td>
</tr>
<tr>
<td><a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5013a1.htm">http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5013a1.htm</a></td>
</tr>
</tbody>
</table>
11. Managing implementation
The guidance contained in this module has been designed to fit in with existing strategic plans for disease surveillance and response and, where applicable, food safety. The drafting of separate plans specifically to address foodborne disease surveillance and response in stage 2 is discouraged. There are several steps a country can take to implement the guidance contained in this module.

**Decision-trees**

Use the decision-trees presented in this module as tools to assess existing capacities and to determine what actions need to be taken to strengthen surveillance and response for foodborne diseases. Some activities in stage 2 are not captured in the decision-trees (e.g. rapid risk assessment, response, ad hoc studies and monitoring and evaluation), but are discussed in the text. Annex 10 lists all of the actions from the decision-trees and the text of this module, and contains a template for recording the information.

It is important to note that the stages and the capacities in the decision-trees are simplified guides to assist countries. Each country will develop its surveillance and response system in its own way. A country does not need to have all capacities in all of the components in stage 1 before moving to stage 2. It may be necessary to refer to the stage 1 module if some of the capacities for one component require more development. Countries in stage 2 that are still developing surveillance and response capacities may also start to consider taking steps towards integrated food chain surveillance, once their laboratory-based surveillance is robust enough and there is goodwill among all of the key stakeholders.
Identifying priority capacities for implementation

Once the capacities that require strengthening have been identified, activities for implementation should be prioritized. It is important to involve all relevant stakeholders in identifying the priority capacity-building activities. Some criteria in selecting priority activities for implementation include:

- impact on the surveillance and response system;
- available resources (e.g. financial and human resources);
- ease of implementation.

The priorities can be documented for each capacity-building activity in the template in Annex 10.

Ideally, countries should give priority to activities that will increase the impact of the surveillance and response system and that can be implemented with the financial and human resources available. However, some capacities will require significant investments; the information in this module may be used in drafting proposals for funding to strengthen surveillance and response for foodborne diseases. In stage 2, many of the activities undertaken to strengthen the surveillance and response system for foodborne diseases will have benefits for the broader surveillance and response system for other diseases under surveillance.

Strategic plans

Initially, a country may add the completed template from Annex 10 to their existing surveillance and response strategic plans. As further national strategic plans are developed, the activities for strengthening surveillance and response for foodborne diseases can be incorporated.
Annex 1.
Identifying priorities for surveillance and response in stage 2
The main principle of disease prioritization is that all key stakeholders should collaborate in drawing up a list of diseases for surveillance in a systematic, transparent and objective manner. A defined prioritization technique can provide a structured mechanism for objectively ranking foodborne diseases and making sometimes difficult decisions. It also helps to gather input from a variety of stakeholders, including food safety partners, and to take into consideration other competing health issues within the country.

The steps for prioritizing diseases are as follows.

1. Establish criteria.
2. Collect information.
3. Make decisions.
4. Translate priorities into surveillance options.

**Step 1. Establish criteria**

The first step is to agree a set of criteria for objectively assessing each disease and syndrome under consideration. The parameters listed in Table A1.1 can help guide the development of the criteria. These parameters should be examined not only from the national perspective but also from a regional, and possibly international, perspective, depending on the trade implications and the potential for cross-border spread. Additional criteria can be added to the list, depending on the needs of the country.
### TABLE A1.1.
Possible criteria for identifying priority diseases for surveillance in stage 2

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Parameters to consider</th>
</tr>
</thead>
</table>
| Disease burden (size of the health problem, severity of clinical outcomes) | • Percentage of cases attributable to foodborne transmission  
• Annual incidence rate  
• Vulnerability of the exposed population groups (by sex, age, ethnicity)  
• Case–fatality ratio  
• Rate of hospitalization  
• Nature and frequency of long-term disabilities |
| Information about the hazards | • Food monitoring data for chemical residues in food  
• Food monitoring data for microbial pathogens |
| Epidemiological features | • Disease that occurs in outbreaks that have been attributed to a food source  
• Disease trends over time: is the incidence rate increasing? |
| Availability of treatment or effective control | • Possibility of applying specific prevention or control measures  
• Availability and nature of treatment |
| Social and economic costs | • Estimate of economic cost of the disease  
• Impact on tourism and international trade  
• Public perceptions of risk |
| Feasibility | • Availability of reliable diagnostic tests  
• Ability to carry out surveillance for the disease |

### Step 2. Collect information to guide prioritization process

Once the criteria for assessing priority have been established, the relevant information on the criteria has to be collected for each disease and syndrome under consideration. Table A1.2 indicates some possible sources of information. When considering information sources, it is important to understand how the data are collected, analysed and reported. There may be biases in the methods of collection or analysis that may make a disease or hazard appear to be more of a problem than it really is. For example, when considering food monitoring data on chemical residues, it will be important to know the full list of chemicals tested for. Similarly, when considering the pathogens most frequently identified during outbreaks, it will be important to know the range of pathogens tested for.
The collected data can then be entered into a table (Table A1.3), which allows easy comparison of the key criteria. Where possible, data to complete the table should come from existing sources. For countries at the beginning of stage 2, there may be a lack of data for certain criteria; these data gaps should also be documented.

**TABLE A1.2.**

Possible sources of information on criteria for establishing priorities for surveillance in stage 2

<table>
<thead>
<tr>
<th>Information source</th>
<th>Extra resources required?</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Existing surveillance data, e.g. trends in diarrhoeal syndromes | No                        | • The data do not provide specific information on foodborne diseases but can be used, along with other data (e.g. multiple outbreak data or results of prevalence surveys in animals or humans) to draw conclusions about trends.  
  • Captures trends over time  
  • Notifiable systems might cover the whole country  
  • High specificity for foodborne diseases where there is laboratory confirmation | • Low specificity where syndromes (without laboratory confirmation) are used  
  • Without other sources of data, the sensitivity for foodborne diseases may be low |
| Outbreak response data                                   | No                        | • Data from multiple outbreaks can provide an indication of the burden of outbreak-prone foodborne diseases | • Low sensitivity, as the data are only from detected outbreaks where a foodborne pathogen is identified |
| Existing ad hoc research studies                         | No                        | • May provide specific information about foodborne hazards to supplement existing surveillance and outbreak data | • May not specifically address criteria for prioritization |
| Food monitoring                                          | No                        | • Captures information about the main hazards being found in food  
  • Especially important for establishing priorities for chemical hazards | • A limited range of hazards may be tested for  
  • A limited range of foods may be tested |
| Foodborne disease burden estimates                       | Yes                       | • Most accurate way to determine the burden of gastroenteritis thought to be foodborne in origin | • Can be expensive |
(TABLE A1.2. Continue)

<table>
<thead>
<tr>
<th>Information source</th>
<th>Extra resources required?</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food consumption data</td>
<td>Maybe</td>
<td>• There may be existing food consumption data that can be used with food monitoring data to assess chemical risks in foods (WHO, 2009)</td>
<td>• Can be expensive</td>
</tr>
<tr>
<td>Total diet studies</td>
<td>Yes</td>
<td>• Most accurate way to measure concentrations of chemical residues in food</td>
<td>• Can be expensive</td>
</tr>
</tbody>
</table>

**TABLE A1.3.**

**Template for summarizing data on diseases and syndromes as part of the prioritization process**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Disease 1</th>
<th>Disease 2</th>
<th>Disease 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disease burden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of annual cases attributable to foodborne transmission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual incidence rate per 100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At-risk populations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Male:female ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Age groups most affected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Other high-risk groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case–fatality ratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospitalization rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature and frequency of long-term disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Information about hazards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food monitoring data for chemical residues in food</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food monitoring data for microbial pathogens</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE A1.3. Continue

<table>
<thead>
<tr>
<th>Questions</th>
<th>Disease 1</th>
<th>Disease 2</th>
<th>Disease 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epidemiological features</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epidemic potential (do outbreaks occur?)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease trends (is the incidence rate increasing?)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Availability of treatment or control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific prevention or control measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Social and economic costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate of economic cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact on tourism and international trade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public perception of risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Feasibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of reliable diagnostic tests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to conduct surveillance for the disease</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Step 3. Make decisions**

There are several options for making decisions about foodborne disease priorities. The choice will depend on the resources available and the number and diversity of stakeholders in the process. The two main approaches are strategy grids and a Delphi panel.
Strategy grids

Strategy grids are recommended for use in countries where resources are limited and the main focus is on identifying the foodborne diseases for which surveillance will have the biggest impact. Using the data collected in Table A1.3, all of the diseases considered in the prioritization process can be ranked in a strategy grid. The criteria used for the strategy grids are flexible – any of the criteria from step 1 could be used to make a strategy grid. An example using disease burden and feasibility of conducting surveillance is shown in Figure A1.1. However similar strategy grids could be drawn up for disease burden and capacity to control or prevent disease, or for feasibility of conducting surveillance and social and economic impact.

**FIGURE A1.1.**

*Strategy grid to set priorities for foodborne disease surveillance, using disease burden and feasibility*

<table>
<thead>
<tr>
<th>High disease burden, low feasibility</th>
<th>High disease burden, high feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>The surveillance of these foodborne diseases is a long-term project. Options for surveillance will require significant investment. Focusing on too many of these diseases can overwhelm the surveillance system and compromise its overall performance.</td>
<td>These diseases should be a high priority and sufficient resources should be assigned to their surveillance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low disease burden, low feasibility</th>
<th>Low disease burden, high feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>With minimal return on investment, these are the lowest priority foodborne diseases and should not be included in the surveillance system.</td>
<td>Often politically important (as they are rare but may be high-impact diseases, such as botulism), these diseases may need to be considered as more resources become available. It may also be possible to gather information on these diseases using ad hoc research studies.</td>
</tr>
</tbody>
</table>
Delphi panel approach

When there are many criteria in the priority-setting process, many diseases to choose from, or where the input from a wide variety of stakeholders needs to be considered, the Delphi approach is the recommended method of identifying priorities. The process has been described in detail in WHO (2006b) guidelines, and can be summarized as follows.

- Identify key stakeholders to be part of the prioritization process.
- Ask participants to score the diseases against the criteria.
- Weight and sum the results for each participant.
- Rank the diseases, then ask participants to assess the ranking.
- Discuss and finalize the results.

Modifications of this approach have been used with success in a range of settings with widely differing resources, such as Germany and the Federated States of Micronesia (Krause, 2008; Gilsdorf & Krause, 2011; Pavlin et al., 2010). The scoring and weighting of the criteria for prioritization make the process transparent, reproducible and less likely to be dominated by the more vocal participants. The steps involved in the process are shown in Figure A1.2.
Step A. Define scores for each criterion

A standard scoring system needs to be developed for the criteria developed in step 1. Commonly used scores are +1 for criteria of high importance, -1 for criteria of low importance and 0 for those of medium importance. For each criterion, thresholds should be defined for each score. Table A1.4 shows how a matrix can be constructed to define the scores for each criterion. Some examples of criteria and thresholds used in scoring are given in Krause (2008) and Pavlin et al. (2010).
### Step B. Delphi panel: define weights

A panel of experts and key stakeholders who are knowledgeable in the area should be convened. Each member of the panel should rank the criteria in order of importance, assigning the highest number to the most important criterion and 1 to the least important. A weight is calculated for each criterion as the average of the rankings. This process can take place before or during a meeting of the panel of experts.

### Step C. Delphi panel: assign scores for each criterion

A meeting of the panel of experts then considers the data collected in step 2 and collectively decides on the score for each criterion.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Score</th>
<th>-1</th>
<th>0</th>
<th>+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease incidence</td>
<td>Fewer than 1 case per 100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1–20 cases per 100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than 20 cases per 100 000 population</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step D. Apply weights and sum scores

Each criterion score is then multiplied by the weighting from step B and all the criteria scores are summed to give an overall score for each hazard.

Step E. Rank the hazards

Once the weighting and scores have been calculated, the diseases are ranked in order from the highest score to the lowest.

Step F. Delphi panel: discussion and consensus

The expert panel should then examine the ranked list of hazards and discuss the results at a meeting. There may need to be a consensus approach depending on the results of the ranking.

Step 4. Translate priorities into surveillance options

Once a list of priority hazards has been drawn up, the surveillance options for each hazard need to be considered. Table A1.5 lists the options based on a general grouping of hazards. Laboratory-based surveillance is the most appropriate option for microbial hazards that require further characterization. However, it may not be necessary or desirable to have laboratory-based surveillance for some rare high-impact diseases, such as botulism and haemolytic uraemic syndrome (HUS). Chemical hazards, including pesticides and natural toxins, require a targeted approach using ad hoc research studies. Parasites may also be measured through ad hoc research studies or burden of disease studies, until laboratory capacity is sufficient for diagnostic tests to be performed routinely.
### TABLE A1.5.

**Surveillance options for different priority hazards**

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Example</th>
<th>Surveillance option</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microbial hazards</strong></td>
<td><em>Salmonella, Shigella, Shiga-toxin-producing E.coli, Campylobacter, hepatitis A</em></td>
<td>Laboratory-based surveillance</td>
<td>Strong laboratory capacity is needed to keep these pathogens under surveillance</td>
</tr>
<tr>
<td>Acute diarrhoea</td>
<td>Notifiable disease surveillance</td>
<td></td>
<td>Early in stage 2, diarrhoea will still be important as a notifiable syndrome, until laboratory capacity improves.</td>
</tr>
</tbody>
</table>
| **Rare high-impact diseases** | Botulism                                                                | Strengthened notifiable disease surveillance       | • Distinctive clinical presentation  
• Given that it is a rare disease, laboratories may not have the capacity to conduct testing                                                                                                                                                  |
| Haemolytic uraemic syndrome   | Strengthened notifiable disease surveillance; laboratory confirmation required |                                                    | • Rare complication of STEC infection, but may also be caused by other factors. It is therefore essential that HUS cases are tested for STEC.  
• Clinical presentation part of case definition for HUS, but blood tests are needed for confirmation                                                                                                           |
| **Chemical hazards**          | Pesticides                                                              | Ad hoc research studies, such as total diet studies, population-based surveys | • Only involvement with surveillance and response system would be for acute events that may be detected through EBS.  
• Ad hoc research studies are required to answer questions related to chemical hazards                                                                                                               |
| Natural toxins (e.g. aflatoxins, mushroom toxins) | Ad hoc research studies, such as total diet studies, population-based surveys |                                                    | • Only involvement with surveillance and response system would be for acute events that may be detected through EBS.  
• Ad hoc research studies are required to answer questions related to natural toxins                                                                                                                                   |
### Table A1.5. Continue

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Example</th>
<th>Surveillance option</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasites</td>
<td>Cryptosporidium, Trichinella, Cyclospora</td>
<td>Ad hoc research studies, burden of disease studies, existing control programmes for specific diseases</td>
<td>Early in stage 2, it is unlikely that there will be laboratory capacity to detect parasites.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laboratory-based surveillance</td>
<td>Once laboratory capacity begins to develop, it may be possible to include high priority parasites in laboratory surveillance.</td>
</tr>
</tbody>
</table>
Annex 2.
Further characterization of bacterial foodborne pathogens
Table A2.1 summarizes the laboratory methods currently used for further characterization of the main bacterial foodborne pathogens. Most of these methods rely on obtaining an isolate from culture.

Laboratory technology is evolving rapidly, and the initial identification of pathogens may already be done using nucleic acid testing (PCR methods). If the PCR result is positive for a foodborne agent, attempts are then made to culture the organism from the clinical specimen. Once an isolate has been obtained, it can be further characterized.

Whole genome sequencing (WGS) is a relatively new laboratory technique for further characterization of foodborne agents. WGS is likely to have a profound impact on the surveillance of foodborne bacterial pathogens. However, it is currently unclear exactly how WGS will be used to monitor trends and detect clusters of foodborne disease.

### TABLE A2.1.

**Summary of the laboratory methods currently used for further characterization of the main bacterial foodborne pathogens**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Speciation</th>
<th>Serovar/serotype</th>
<th>Phage type</th>
<th>MLVA</th>
<th>MLST</th>
<th>PFGE</th>
<th>Whole genome sequencing</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella</em> Non Typhoid/paratyphoid</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>There are over 2500 serotypes of <em>Salmonella</em>. Antigenic testing using the White-Kauffmann-LeMinor scheme (Grimont &amp; Weill, 2007) has been the international standard for <em>Salmonella</em> typing. Some countries have moved to PFGE and MLVA for cluster detection of some Salmonella serovars. WGS is being used for further characterization in outbreaks. Recent work by Achtman et al. (2012) suggests MLST could replace serotyping for <em>Salmonella enterica</em>.</td>
</tr>
<tr>
<td>Pathogen</td>
<td>Speciation</td>
<td>Serovar/serotype</td>
<td>Phage type</td>
<td>MLVA</td>
<td>MLST</td>
<td>PFGE</td>
<td>Whole genome sequencing</td>
<td>Comments</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
<td>----------------</td>
<td>------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>-------------------------</td>
<td>----------</td>
</tr>
<tr>
<td><em>Salmonella</em> Typhoid/paratyphoid fever</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>These serotypes, strictly adapted to humans, are homogenous populations. PFGE is limited for outbreak discrimination, MLVA schemes have not been validated yet.</td>
<td></td>
</tr>
<tr>
<td><em>Campylobacter</em></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Generally <em>Campylobacter</em> is ubiquitous and further typing is expensive. For routine surveillance, identification of <em>Campylobacter</em> is sufficient. However, speciation and further typing using MLST can be used for source attribution studies or for assessing genetic relatedness in an outbreak.</td>
<td></td>
</tr>
<tr>
<td>Shiga-toxin-producing <em>E.coli</em> (STEC)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>The most important laboratory test for the diagnosis of STEC is the detection of the Shiga-toxin-producing genes by PCR, regardless of the serotype. For routine surveillance, identification at the serotype level is sufficient for cluster detection. In an outbreak situation further typing is needed, e.g. MLVA, PFGE, MLST, WGS.</td>
<td></td>
</tr>
<tr>
<td><em>Shigella</em></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>There are four species of <em>Shigella</em>, three of which are made up of multiple serotypes. For routine surveillance, identification at the serotype level is sufficient for cluster detection. MLVA could be used in outbreak situations, in particular <em>S. sonnei</em> (Chiou et al., 2013). <em>Shigella</em> and <em>Escherichia coli</em> are closely related genetically.</td>
<td></td>
</tr>
<tr>
<td><em>Listeria</em></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>Generally one case of <em>L. monocytogenes</em> triggers a public health response. Further typing is required for cluster detection and outbreak investigation. All isolates should be further characterized.</td>
<td></td>
</tr>
<tr>
<td><em>Yersinia</em></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Identification of <em>Y. enterocolitica</em> and <em>Y. pseudotuberculosis</em> is required. Many biotypes of <em>Y. enterocolitica</em> are non-pathogenic, so further typing is generally required.</td>
<td></td>
</tr>
</tbody>
</table>
(TABLE A2.1. Continue)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Speciation</th>
<th>Serovar/serotype</th>
<th>Phage type</th>
<th>MLVA</th>
<th>MLST</th>
<th>PFGE</th>
<th>Whole genome sequencing</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibrio cholerae</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Two main serogroups of <em>V. cholerae</em>, O1 and O139, cause epidemic cholera. Serogroup O1 has three serotypes (Ogawa, Inaba and Hikojima) and two biotypes (classical and El Tor). PFGE is the gold standard method for outbreak typing. Several MLVA schemes have been established.</td>
</tr>
<tr>
<td>Other Vibrio spp. (e.g. <em>V.</em> parahaemolyticus)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex 3.
Mapping laboratory capacities for further characterization
Table A3.1 provides an example of a template that can be used to map out the laboratory capacities for further characterization in stage 2. The template should be completed for each pathogen under surveillance, with specification of the typing methods available in the country and the laboratories that can perform the testing. Examples are presented in the template in italics.

**TABLE A3.1.**

**Template for mapping laboratory capacities in a country**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Further characterization method</th>
<th>Laboratories performing the tests</th>
<th>Routine surveillance</th>
<th>Outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella</em></td>
<td><strong>Serovar</strong></td>
<td>Laboratory X, Y, Z</td>
<td>As for routine surveillance</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Phage typing</strong></td>
<td>Laboratory Y, Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>MLVA</strong></td>
<td>Laboratory Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PFGE</strong></td>
<td>Laboratory X, Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>WGS</strong></td>
<td>Laboratory Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Shiga-toxin-producing E.coli</em></td>
<td><strong>Serotyping using PCR</strong></td>
<td>Laboratory X, Y, Z</td>
<td>As for routine surveillance</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Serotyping using antigen testing</strong></td>
<td>Laboratory Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>MLVA</strong></td>
<td></td>
<td>Laboratory Z</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>WGS</strong></td>
<td></td>
<td>Laboratory Z</td>
<td></td>
</tr>
<tr>
<td><em>Campylobacter</em></td>
<td><strong>Species</strong></td>
<td>Laboratory X, Y</td>
<td>As for routine surveillance</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>MLST</strong></td>
<td></td>
<td>Laboratory X</td>
<td></td>
</tr>
<tr>
<td><em>Listeria</em></td>
<td><strong>Species</strong></td>
<td>Laboratory Y, Z</td>
<td>As for routine surveillance</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Serogroup</strong></td>
<td>Laboratory Y, Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>MLVA</strong></td>
<td>Laboratory Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PFGE</strong></td>
<td>Laboratory Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>WGS</strong></td>
<td>Laboratory Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex 4.
Minimum data requirements for notifiable disease surveillance in stage 2
When the notifiable disease surveillance system shifts from recording aggregated data on syndromes to individual data on laboratory-confirmed diseases, the surveillance database will need to be amended. Table A4.1 shows the minimum data set that would be required for foodborne diseases in stage 2.

**TABLE A4.1.**  
**Minimum data set required for foodborne diseases collected as part of a notifiable disease surveillance system**

<table>
<thead>
<tr>
<th>Data variable</th>
<th>Data format</th>
<th>Description of data variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Text</td>
<td>Surname and first name</td>
</tr>
<tr>
<td>Date of birth</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>Categorical</td>
<td>Important for case follow-up, investigation and descriptive epidemiology. Should include all the relevant information to identify the geographical location of the home. This is especially important if the information will be mapped</td>
</tr>
<tr>
<td>Residential address</td>
<td>Text</td>
<td>Important for case follow-up, investigation and descriptive epidemiology. Should include all the relevant information to identify the geographical location of the home. This is especially important if the information will be mapped</td>
</tr>
<tr>
<td>Phone number(s)</td>
<td>Text</td>
<td>Important for case follow-up</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Categorical</td>
<td>May be limited to vulnerable subpopulations</td>
</tr>
<tr>
<td>Disease</td>
<td>Categorical</td>
<td>Disease reported</td>
</tr>
<tr>
<td>Date of symptom onset</td>
<td>Date</td>
<td>Date first symptom began; important for identifying period of exposure</td>
</tr>
<tr>
<td>Date of report</td>
<td>Date</td>
<td>Date reported by doctor or laboratory</td>
</tr>
<tr>
<td>Date of specimen collection</td>
<td>Date</td>
<td>Date specimen was collected</td>
</tr>
<tr>
<td>Pathogen/chemical/agent</td>
<td>Categorical</td>
<td>Specific details about the pathogen, chemical or agent causing disease, including typing information. This may be split over 2 or 3 data fields and may require associated date fields for each typing result.</td>
</tr>
<tr>
<td>Died</td>
<td>Categorical</td>
<td>Patient died following foodborne illness</td>
</tr>
<tr>
<td>Date of death</td>
<td>Date</td>
<td>Date patient died</td>
</tr>
<tr>
<td>Data variable</td>
<td>Data format</td>
<td>Description of data variable</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Place of acquisition</td>
<td>Categorical</td>
<td>Record if patient was likely to have acquired the illness locally or while travelling. An additional field may be included to capture country of acquisition for disease acquired outside of the country.</td>
</tr>
<tr>
<td>Notifier details</td>
<td>Text</td>
<td>Name and contact details of notifier for follow-up of case details</td>
</tr>
<tr>
<td>Exposure information</td>
<td>Text</td>
<td>Information from clinical notes that may indicate the likely source of the infection</td>
</tr>
</tbody>
</table>
Annex 5.
An example of a data dictionary for the notifiable disease surveillance database
The data dictionary lists each field in the notifiable disease surveillance database, together with a description of the format of the data, the options for categorical fields and a description of the data rules that may apply.

The example shown in table A5.1 uses a selection of the minimum data requirements specified in Annex 4.

**TABLE A5.1.**

*An example of a data dictionary for the notifiable disease surveillance database*

<table>
<thead>
<tr>
<th>Table A5.1</th>
<th>Description of data variable</th>
<th>Data rules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td>This field contains the first name and surname of the patient.</td>
<td>Often the name (and date of birth) is checked in the system before a new record is created, to ensure that there is no duplication of episodes of illness in the database. A name is also required in case the patient needs to be interviewed as part of an investigation.</td>
</tr>
<tr>
<td><strong>Format of the data</strong></td>
<td>Text</td>
<td></td>
</tr>
<tr>
<td><strong>Specifications for the data</strong></td>
<td>Free text field (100 characters maximum)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table A5.1</th>
<th>Description of data variable</th>
<th>Data rules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date of birth</strong></td>
<td>This field contains the date of birth of the patient.</td>
<td>This field is mandatory and only one date is permitted. Often the date of birth (and name) is checked on the system before a new record is created, to ensure that there is no duplication of episodes of illness in the database.</td>
</tr>
<tr>
<td><strong>Format of the data</strong></td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td><strong>Specifications for the data</strong></td>
<td>DD/MM/YYYY</td>
<td></td>
</tr>
</tbody>
</table>
(TABLE A5.1. Continue)

**Sex**

<table>
<thead>
<tr>
<th>Description of data variable</th>
<th>This field describes the sex of the patient.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format of the data</strong></td>
<td>Categorical</td>
</tr>
</tbody>
</table>
| **Specifications for the data** | 1 = Male  
2 = Female  
3 = Unknown to the notifier  
999 = Not stated by the notifier |
| **Data rules**               | This field is mandatory and only one category is permitted. |

**Residential address**

<table>
<thead>
<tr>
<th>Description of data variable</th>
<th>This field contains the residential address of the patient.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format of the data</strong></td>
<td>Text</td>
</tr>
</tbody>
</table>
| **Specifications for the data** | Free text field (200 characters maximum)  
(Note: This may be one field, or multiple fields, depending on how addresses are recorded in the country) |
| **Data rules**               | This field is mandatory, as location can be used to identify clustering in place and may also be required if patients are interviewed face to face as part of an investigation. |

**Pathogen/chemical/agent (level 1)**

<table>
<thead>
<tr>
<th>Description of data variable</th>
<th>This field contains the agent identified in the clinical specimen collected from the patient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format of the data</strong></td>
<td>Categorical</td>
</tr>
</tbody>
</table>
| **Specifications for the data** | 1 = Disease 1 (e.g. Salmonella)  
2 = Disease 2 (e.g. Shiga-toxin producing E.coli)  
3 = ...[continue the list until all notifiable conditions are included] |
| **Data rules**               | This field is mandatory.                                                                |

**Pathogen/chemical/agent (level 2)**

<table>
<thead>
<tr>
<th>Description of data variable</th>
<th>This field contains further characterization information about the agent identified in the clinical specimen collected from the patient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format of the data</strong></td>
<td>Categorical</td>
</tr>
</tbody>
</table>
| **Specifications for the data** | 1 = further typing 1 (e.g. Typhimurium, for Salmonella)  
2 = further typing 2 (e.g. Enteritidis, for Salmonella)  
3 = further typing 3 (e.g. O157, for STEC)  
4= ...[continue the list until all further typing options for notifiable conditions are included] |
### Date of birth

<table>
<thead>
<tr>
<th>Description of data variable</th>
<th>This field identifies where the illness was acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format of the data</td>
<td>Categorical</td>
</tr>
<tr>
<td>Specifications for the data</td>
<td></td>
</tr>
<tr>
<td>1 = Country 1</td>
<td></td>
</tr>
<tr>
<td>2 = Country 2</td>
<td></td>
</tr>
<tr>
<td>3 = ... (continue the list until all countries have been listed. Some countries have their own classification of countries e.g. Standard Australian Classification of Countries (SACC) <a href="http://www.abs.gov.au/ausstats/abs@.nsf/0/C8B8914F6C683351CA25744D00818CED?opendocument">http://www.abs.gov.au/ausstats/abs@.nsf/0/C8B8914F6C683351CA25744D00818CED?opendocument</a>. Alternatively, there is a list of United Nations Member States <a href="http://www.un.org/en/members/">http://www.un.org/en/members/</a>, which may be a useful starting-point) 888 = Unknown place of acquisition 999 = Place of acquisition was not stated in notification</td>
<td></td>
</tr>
</tbody>
</table>

| Data rules | This field is mandatory. Ensure that your own country is listed as the default field. |
Annex 6.
An example of a surveillance log
It is important to log all the changes that are made to any surveillance system, to allow the data to be correctly interpreted. An example of a surveillance log is provided in table A6.1

**TABLE A6.1**

**Example of a surveillance log**

<table>
<thead>
<tr>
<th>Date of change</th>
<th>Description of change</th>
<th>Responsible officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2002</td>
<td>List of notifiable conditions was updated to include: • diarrhoea; • bloody diarrhoea; • neurological syndrome; • upper respiratory tract infections. Case definitions were drafted for each syndrome. Training has been conducted in all provinces on the syndromes under surveillance, their case definitions and how to send reports.</td>
<td>Person X</td>
</tr>
<tr>
<td>1/7/2005</td>
<td>An electronic database to store surveillance data was introduced. The database replaces the written notebook and manual entry into the Excel spreadsheet. Each province will send its data by email or will be called by the national surveillance team each week.</td>
<td>Person Y</td>
</tr>
<tr>
<td>27/9/2007</td>
<td>National surveillance guidelines have been completed. The guidelines contain information on how the notifiable disease surveillance system functions.</td>
<td>Person T</td>
</tr>
<tr>
<td>3/7/2009</td>
<td>As a result of the national surveillance assessment, all surveillance staff in the provinces are regularly sent phone credits to allow them to report surveillance data every week, so that outbreaks can be detected early.</td>
<td>Person Y</td>
</tr>
<tr>
<td>3/4/2011</td>
<td>Disease prioritization exercise conducted with panel of experts to develop a list of notifiable diseases. The new list of diseases includes <em>Salmonella</em>, <em>Shigella</em>, etc.</td>
<td>Person W</td>
</tr>
<tr>
<td>10/8/2011</td>
<td>New notifiable disease list approved. Plan for laboratories to begin notifying new diseases from 1/1/2012.</td>
<td>Person W</td>
</tr>
<tr>
<td>1/1/2012</td>
<td>Laboratories X and Y began sending surveillance data for <em>Salmonella</em> and <em>Shigella</em>.</td>
<td>Person W</td>
</tr>
</tbody>
</table>
Annex 7. Information sources for rapid risk assessment of a foodborne event
Various sources of information can be used in the assessment of hazard, exposure and context of a foodborne disease events. The table below presents some of these information sources, using an event related to *Vibrio parahaemolyticus* as an example. It is unlikely that all of this information will be available.

Event description: a reference laboratory in country X has confirmed two samples of *V. parahaemolyticus*. At the same time there are reports of clusters of cases of acute diarrhoea in three communities in different parts of the country.

### Background

*V. parahaemolyticus* is a bacterium that naturally inhabits marine environments. Infections in humans occur when people eat contaminated seafood that is raw or undercooked. The main clinical signs of *V. parahaemolyticus* infection are diarrhoea, which is sometimes bloody, abdominal pain, nausea and vomiting. The incubation period is approximately 12–24 hours and symptoms usually last for 1–7 days (Heymann, 2008; Nair et al., 2007).

<table>
<thead>
<tr>
<th>Characteristic being assessed</th>
<th>Information sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazard</strong></td>
<td></td>
</tr>
<tr>
<td>Bacterial factors</td>
<td></td>
</tr>
<tr>
<td>Serotypes involved</td>
<td>Laboratory information: any recent research studies on <em>V. parahaemolyticus</em> undertaken in the country.</td>
</tr>
<tr>
<td></td>
<td>Published literature from other countries about distribution of serotypes.</td>
</tr>
<tr>
<td>Clinical factors</td>
<td></td>
</tr>
<tr>
<td>Clinical presentation</td>
<td>Data from hospital-based IBS for acute diarrhoea: number of cases.</td>
</tr>
<tr>
<td></td>
<td>Data from laboratories about <em>V. parahaemolyticus</em> in humans.</td>
</tr>
<tr>
<td>Severity</td>
<td>Data from hospital-based IBS for acute diarrhoea: number of deaths.</td>
</tr>
<tr>
<td><strong>Exposure</strong></td>
<td></td>
</tr>
<tr>
<td>Agent</td>
<td>Published literature from other countries: outbreak settings, serotypes responsible, food vehicles thought to be responsible for outbreaks</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Food monitoring</td>
<td>Data from food monitoring programmes, of both local food and food for export</td>
</tr>
<tr>
<td>Host</td>
<td></td>
</tr>
<tr>
<td>Epidemiology of the infection in humans</td>
<td>Published research, including cross-sectional studies and outbreak investigations</td>
</tr>
<tr>
<td></td>
<td>Surveillance reports from other countries providing information about the demographics (e.g. age, sex, socioeconomic status) of people infected with <em>V. parahaemolyticus</em>.</td>
</tr>
<tr>
<td></td>
<td>Data from hospital-based IBS for acute diarrhoea</td>
</tr>
<tr>
<td>Characteristic being assessed</td>
<td>Information sources</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>
| Distribution of seafood sources | • Published research or programmes focused on *V. parahaemolyticus* in seafood, e.g. types of seafood infected (shellfish, octopus, prawns, etc.)  
• Data from the agricultural sector about the origin of the seafood |
| **Context**                   |                     |
| Socioeconomic factors         |                     |
| Food sources                  | Agriculture or commerce reports about how much the suspected food items cost and how much is consumed annually |
| Size of the population at risk | • Vital statistics, including distribution of socioeconomic status  
• Food consumption studies (frequency of consumption) for certain seafood items |
| Human behaviour               | • Surveys on health-care-seeking behaviour for those with acute diarrhoea  
• Knowledge, attitudes and practices surveys on the preparation of seafood  
• Anthropological studies about the cultural importance of food choices and how foods are consumed (e.g. raw or cooked) |
| Ecological factors            |                     |
| Climate                       | Meteorological data (rainfall, temperature, humidity) |
| Production                    | Data from the Department of Agriculture on how seafood is produced (e.g. wild caught or farmed) and harvested |
| Programme factors             |                     |
| Strength of the health system | • National health indicator data  
• Annual reports or programme evaluation reports  
• Reports from debriefings of previous events |

Adapted from WHO, 2012.
Annex 8.

Example of a communication mechanism
As multisectoral collaboration becomes stronger in stage 2, it may be necessary to establish a communication mechanism to ensure that there is a clear process that describes what information will be shared amongst the key stakeholders in foodborne diseases and under what circumstances. It is important that the agreed process is written down. Table A8.1. provides an example of how the process can be documented. It will be necessary for the different stakeholders to work together to agree on the actions described in table A8.1. The process should be reviewed annually to ensure the information is accurate and the actions appropriate.

**TABLE A8.1.**

**Information from surveillance and response sector to food safety sector**

<table>
<thead>
<tr>
<th>What will be communicated?</th>
<th>Who will receive the information?</th>
<th>Purpose of the information</th>
<th>Frequency of communication</th>
<th>Method of communication</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute events</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report of suspected foodborne outbreak</td>
<td>Food safety manager</td>
<td>To inform the manager that an investigation has started</td>
<td>Within 24 hours of receipt of report</td>
<td>Email</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Routine communications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual report on foodborne diseases</td>
<td>Food safety team</td>
<td>To inform the food safety team about the notifications of foodborne diseases and provide a summary of key foodborne outbreaks investigated</td>
<td>Each year on completion of the report</td>
<td>Email and presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Information from food safety sector to surveillance and response sector

<table>
<thead>
<tr>
<th>What will be communicated?</th>
<th>Who will receive the information?</th>
<th>Purpose of the information</th>
<th>Frequency of communication</th>
<th>Method of communication</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute events</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food item contaminated with Salmonella</td>
<td>Surveillance and response manager</td>
<td>To inform the manager that a food item is contaminated with Salmonella</td>
<td>Within 24 hours of receipt of report</td>
<td>Email</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Routine communications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual report on food safety</td>
<td>Surveillance and response team</td>
<td>To provide information about food safety</td>
<td>On completion of the report</td>
<td>Email and presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex 9
Examples of monitoring indicators for foodborne diseases
Table A9.1 suggests some indicators for ongoing monitoring of each component of the surveillance and response system for foodborne diseases in stage 2.

TABLE A9.1.

<table>
<thead>
<tr>
<th>Component</th>
<th>Proposed indicator</th>
<th>Numerator</th>
<th>Denominator</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBS</td>
<td>Time between obtaining laboratory result and reporting to the notifiable disease surveillance system</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Proportion of pathogens adequately characterized to allow cluster detection</td>
<td>Number of cases reported for which pathogens have been further typed</td>
<td>Total number of cases reported for pathogens that are able to be further typed</td>
<td></td>
</tr>
<tr>
<td>Completeness of the core data fields (specified in minimum data requirements)</td>
<td>The number of valid entries that adhere to the data specifications for the data field</td>
<td>Total number of entries for the data field</td>
<td></td>
</tr>
<tr>
<td>Number of surveillance bulletins produced each year</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>EBS</td>
<td>Proportion of reports from outside the health system</td>
<td>Number of event reports from outside the health system</td>
<td>Total number of events reported</td>
</tr>
<tr>
<td>Rapid risk assessment</td>
<td>Proportion of subnational sites that are able to conduct rapid risk assessments</td>
<td>Number of subnational sites that are able to conduct rapid risk assessments</td>
<td>Total number of subnational sites</td>
</tr>
<tr>
<td>Response</td>
<td>Average length of time for case interviews</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Number of subnational sites that have performed analytical epidemiological studies (e.g. case–control and cohort studies)</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Proportion of investigations for which a debriefing was conducted</td>
<td>Number of foodborne event investigations for which a debriefing was conducted</td>
<td>Total number of foodborne events investigated</td>
<td></td>
</tr>
<tr>
<td>Multisectoral collaboration</td>
<td>Number of times coordinating body meets to discuss foodborne disease issues</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A = not applicable
Annex 10.
Managing implementation in stage 2
The template below summarizes the capacities to be strengthened in a surveillance and response system for foodborne diseases in stage 2. This template can be completed to provide an overview of the current situation and help identify the priority capacities for strengthening.

1. Many of the rows in the template correspond to a point in one of the decision-trees in this module. Refer to the relevant decision-tree and accompanying text for more explanation. Some components of the surveillance and response system in stage 2, however, are not reflected in the decision-trees, e.g. rapid risk assessment, response, ad hoc studies and monitoring and evaluation. The general capacities required to strengthen these components, which are described in the text of the relevant sections, are also included in the template.

2. For each capacity, note whether it currently exists in the country. If the answer is “yes”, move on to the next row.

3. If the capacity does not exist, determine the level of priority for strengthening using the following criteria:

- **Impact**: the impact of the activity on the surveillance and response system for foodborne diseases; score as high (3), medium (2) or low (1) impact;

- **Resources**: the resources (e.g. financial and human) required for implementation of the activity; score as few (3), medium (2) or many (1) resources;

- **Ease of Implementation**: the ease with which the activity can be implemented; consider political and organizational acceptability, approval processes, access to technical skills, organizational changes required, access to required resources: score as easy (3), neutral (2) or difficult (1);

- **Priority**: sum the scores for impact, resources and ease of implementation, to assign a priority to the capacity-building activity. This scoring system...
Stage two

will mainly be useful for identifying easily achievable capacities over a 1–2 year period. It is important that longer-term capacity building, which will have a lower score, is also reflected in the workplan, to help plan for future strengthening activities, such as building epidemiological capacity for outbreak investigations.

4. Define the actions that will be taken to meet the capacity.

5. Set a timeframe for implementation. Aim to identify actions that can be taken within a 12-month period.

6. Assign an officer to be responsible for each implementation activity.

<table>
<thead>
<tr>
<th>Capacities</th>
<th>Capacity exists (yes/no)</th>
<th>Priority for implementation*</th>
<th>Actions</th>
<th>Timeframe</th>
<th>Person responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator-based surveillance: strengthening the role of the laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Priority foodborne diseases have been identified for surveillance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical specimens are being routinely collected from patients according to the specimen collection protocol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The specimen collection protocol documents:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• objectives of surveillance,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• which specimens will be collected,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• when the specimens will be collected,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• how they will be collected,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• how they will be transported</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the laboratories where testing can be performed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacities</td>
<td>Capacity exists (yes/no)</td>
<td>Priority for implementation*</td>
<td>Actions</td>
<td>Timeframe</td>
<td>Person responsible</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>-------------------------------</td>
<td>---------</td>
<td>-----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Clinical specimens are being tested according to the laboratory testing protocol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The laboratory testing protocol for clinical specimens documents:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• how laboratory testing is organized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• instructions for further characterization of priority foodborne pathogens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• instructions for antimicrobial susceptibility testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A database houses laboratory-based surveillance data, with a data dictionary to support its operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A surveillance log is available to document changes in the laboratory-based surveillance system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory results are routinely sent to the surveillance system according to the data reporting protocol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The data reporting protocol includes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• who will send data to the surveillance system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• what data will be sent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• how often the data should be sent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• actions that will be taken based on the information sent to the surveillance system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacities</td>
<td>Capacity exists (yes/no)</td>
<td>Priority for implementation*</td>
<td>Actions</td>
<td>Timeframe</td>
<td>Person responsible</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>------------------------------</td>
<td>---------</td>
<td>-----------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Antimicrobial susceptibility testing is being performed on priority foodborne pathogens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory methods and reporting nomenclature are consistent across laboratories so that results can be compared nationally</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevant sequencing information is being shared internationally for priority foodborne pathogens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Indicator-based surveillance: strengthening notifiable disease surveillance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Priority foodborne diseases have been identified for notifiable disease surveillance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing laws and decrees for the process of notification are up to date and include priority foodborne diseases</td>
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<tr>
<td>Case definitions exist for all notifiable diseases under surveillance</td>
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<tr>
<td>There are notification forms and a clear mechanism for reporting to the surveillance system</td>
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<tr>
<td>Laboratories and health care workers are aware of their obligations to report notifiable diseases</td>
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<tr>
<td>There is a notifiable disease surveillance system database capable of storing data on individuals</td>
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</tbody>
</table>
Stage two

<table>
<thead>
<tr>
<th>Capacities</th>
<th>Capacity exists (yes/no)</th>
<th>Priority for implementation*</th>
<th>Actions</th>
<th>Timeframe</th>
<th>Person responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Impact</td>
<td>Resources</td>
<td>Ease of implementation</td>
<td>Priority</td>
</tr>
</tbody>
</table>

| A data dictionary exists to support the operation of the surveillance database | Yes | | | | |
| There is a surveillance log to document changes to the surveillance system | Yes | | | | |
| There are disease-specific surveillance logs (once laboratory-confirmed pathogens become nationally notifiable) | Yes | | | | |
| Surveillance data are analysed regularly | Yes | | | | |
| Surveillance data are reported in a surveillance bulletin | Yes | | | | |
| Cluster detection methods are applied to surveillance data | Yes | | | | |
| Surveillance protocols document the processes in the surveillance system | Yes | | | | |

**Event-based surveillance**

<table>
<thead>
<tr>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>There is a 24-hour telephone number, fax or email to receive reports at the national level</td>
<td></td>
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<tr>
<td>Reporters outside of the health system have been identified and trained to recognize and report foodborne events</td>
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</tr>
<tr>
<td>Active scanning of the media for foodborne events</td>
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</tbody>
</table>
## Capacities

<table>
<thead>
<tr>
<th>Capacities</th>
<th>Capacity exists (yes/no)</th>
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<th>Timeframe</th>
<th>Person responsible</th>
</tr>
</thead>
</table>

### Rapid risk assessment of foodborne events

- **Staff have been designated at subnational level who can conduct rapid risk assessments**
- **The staff have been trained on how to conduct rapid risk assessments using foodborne events as examples**
- **A mechanism is in place to offer technical support and advice from the national level to the subnational level, when required**
- **Laboratory data are used in rapid risk assessments of foodborne events**

### Response

- **There are disease-specific questionnaires for priority foodborne pathogens**
- **Analytical epidemiological studies are conducted at national and subnational levels**
- **Representatives from food safety and laboratories are routinely part of outbreak response teams**
- **There are training opportunities in analytical epidemiology in the country**

### Ad hoc research studies

- **A mechanism exists for discussing, agreeing, planning and undertaking ad hoc research studies**
There is a communication mechanism between food safety stakeholders, which documents:
- what information is to be shared
- when the information is shared
- who needs to know the information
- how the information will be shared

There is multisectoral involvement in risk profiling of food safety problems

Monitoring indicators have been adjusted to include:
- laboratory confirmed foodborne diseases for IBS;
- increase sensitivity and specificity of EBS;
- subnational capacity for rapid risk assessment and response;
- increased multisectoral collaboration.

The surveillance and response system has been evaluated in the past 5-10 years

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* Priority is the sum of the scores for impact, resources and ease of implementation. This priority score should only be used as a guide to help identify easily achievable capacities, but long-term capacity building, which usually has a low score, should also be reflected in this work plan.
References


