

Integrating surveillance data to better understand risks across the food chain



Stage Three Booklet

Strengthening surveillance of
and response to foodborne diseases

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Strengthening surveillance of and response to foodborne diseases: a practical manual. Stage 3. Integrating surveillance data to better understand risks across the food chain

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Acronyms used in this module

AGISAR	WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance
AMR	antimicrobial resistance
CDC	Centers for Disease Control and Prevention (of the United States of America)
CIPARS	Canadian Integrated Program for Antimicrobial Resistance Surveillance
DANMAP	Danish Integrated Antimicrobial Resistance Monitoring and Research Programme
EBS	event-based surveillance
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
FAO	Food and Agriculture Organization of the United Nations
IBS	indicator-based surveillance
MLST	multilocus sequence typing
MLVA	multilocus variable tandem repeat analysis

NARMS	National Antimicrobial Resistance Monitoring System for Enteric Bacteria
PFGE	pulsed field gel electrophoresis
WGS	whole genome sequencing
WHO	World Health Organization



1.

How to
use this module

This module is intended for countries that are in stage 3 of strengthening their surveillance and response system for foodborne diseases, and contains specific guidance on sharing data in order to better understand risks in the food chain. Integrated food chain surveillance allows risks to be assessed, managed and communicated using risk analysis.

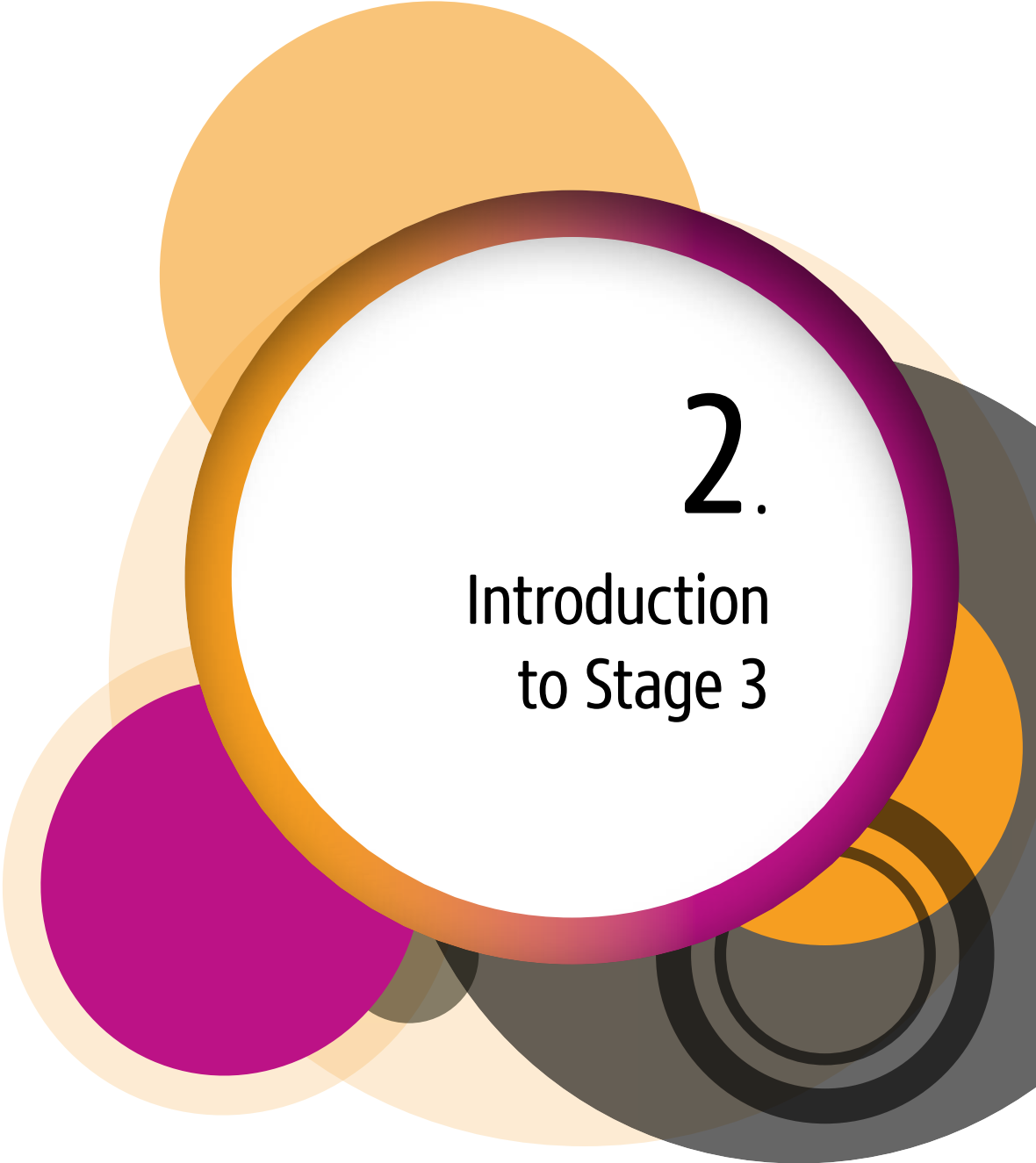
Users of this module are encouraged to read first the introductory module of this manual, which sets the context for the guidance contained here and defines the scope and target audience. It also contains a glossary of technical terms and discusses the different risk-related terms used in the various disciplines involved in the prevention and control of foodborne diseases.

Focusing on stage 3, the present module helps countries build on the capacities developed in stages 1 and 2. Readers should cross-refer to the stage 1 and stage 2 modules, where necessary.

The present module contains specific advice on:

- ✓ approaches to integrated food chain surveillance;
- ✓ how to integrate surveillance data across the food chain;
- ✓ monitoring and evaluation;
- ✓ managing implementation

Section 4 contains a decision-tree, which displays a step-by-step pathway for developing capacities for surveillance and response for foodborne diseases in stage 3. Section 7, 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 3

A country in stage 3 of strengthening its surveillance and response system for foodborne diseases already has a fully functional surveillance and response system in the health sector and is ready to move towards integrated food chain surveillance. The focus in stage 3 is on the routine and systematic sharing of data from the health sector with the animal health and food safety sectors. Routine risk analysis is conducted using the data collected along the food chain, to identify strategies for controlling and preventing foodborne diseases in humans. The food chain includes primary production (including feeds, agricultural practices and environmental conditions that could lead to the contamination of crops and animals), product design and processing, transport, storage, distribution, marketing, preparation and consumption (FAO/WHO, 2007).

This module describes:

- ✓ approaches to integrated food chain surveillance;
- ✓ how to conduct integrated food chain surveillance,

Minimum requirements



Minimum requirements

Countries planning to move to stage 3 should already have the following components in place:

- a fully functional notifiable disease surveillance system, which is laboratory-based and which can monitor trends in foodborne diseases and detect foodborne outbreaks;
- a fully functional event-based surveillance system capable of detecting foodborne events;
- a rapid risk assessment capacity capable of gathering data on, assessing and assigning a level of risk to potential foodborne events, including outbreaks;
- outbreak response teams that have the ability to identify food sources using analytical epidemiological studies and laboratory evidence during foodborne outbreaks;
- a history of conducting ad hoc research studies to answer specific questions about foodborne diseases, such as food source attribution and burden of foodborne disease studies;
- a strong history of successful multisectoral collaboration, through which existing data have been shared on an ad hoc basis to compile risk profiles.

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 3 in relation to foodborne diseases are to:

- ✓ detect and respond to foodborne events, to allow rapid implementation of control measures;
- ✓ monitor trends to understand the epidemiology of foodborne diseases (e.g. geographical distribution of diseases, seasonality and vulnerable populations);
- ✓ determine the magnitude of the problem of foodborne diseases;
- ✓ motivate targeted ad hoc research about foodborne diseases;
- ✓ attribute food sources to specific foodborne diseases;
- ✓ inform clinical management policy, where appropriate (e.g. regarding antimicrobial resistance in humans);
- ✓ inform antimicrobial use policy in food-producing animals and horticulture;
- ✓ inform risk-based inspection services;
- ✓ monitor and evaluate interventions and measures taken to control foodborne diseases;
- ✓ contribute data from the human health sector for integration with data from all sectors across the food chain, to guide public health action to prevent and control foodborne diseases

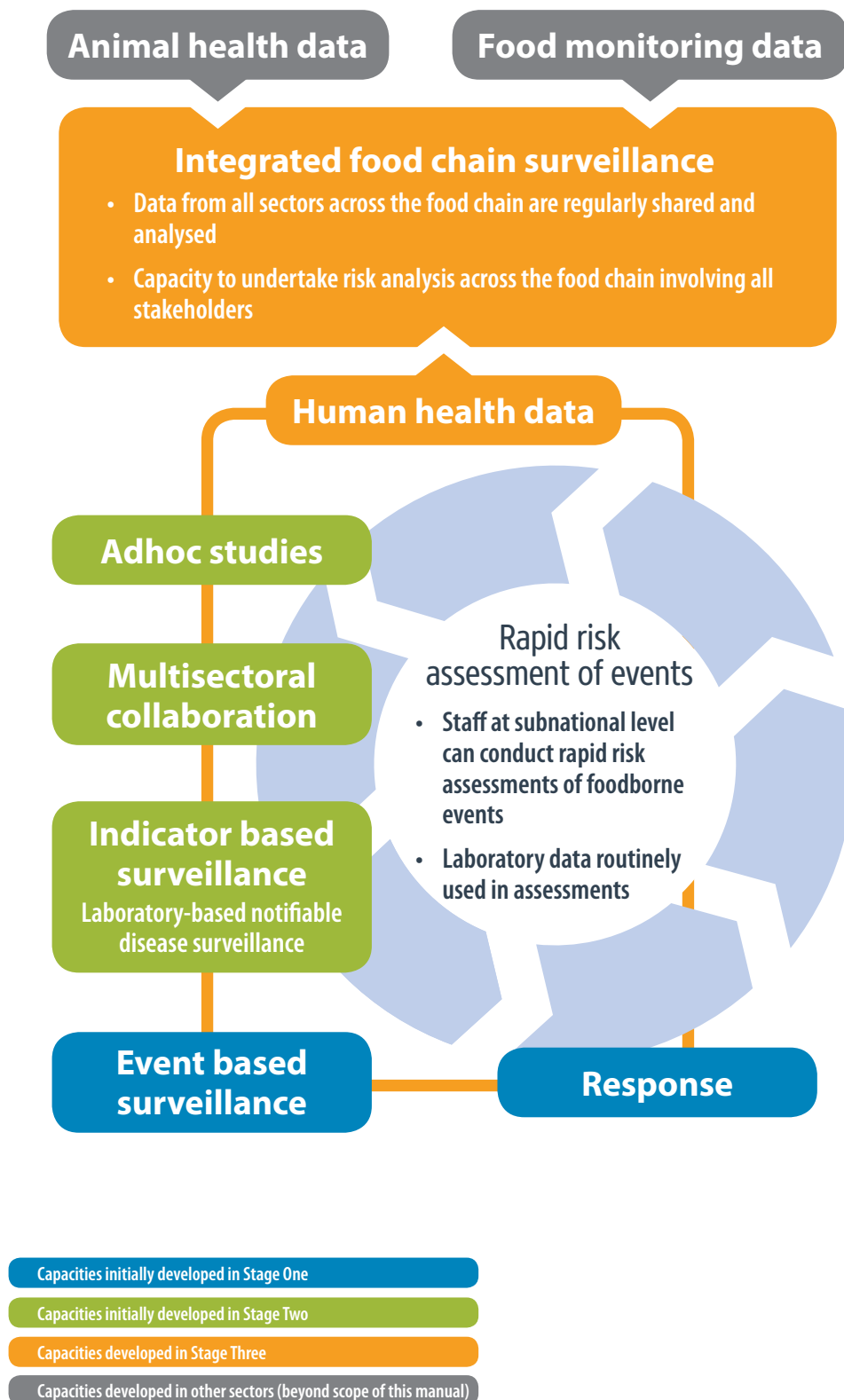
Vision for the surveillance and response system

The vision is a description of what the surveillance and response system will look like at the end of stage 3. By the end of stage 3, the system should allow data on foodborne diseases from the human health sector to be shared with other sectors across the food chain (Figure 1). The aim of sharing data is to guide interventions that will ultimately reduce the burden of foodborne diseases in human populations. For example, data from the integrated food chain surveillance system could be used in risk analysis by food regulators.

The structure of the surveillance and response system for foodborne diseases developed in stages 1 and 2 will not need to be significantly changed in order to participate in integrated food chain surveillance. However, mechanisms for sharing data will need to be created.

FIGURE 1.

Components of the surveillance and response system for foodborne diseases in stage 3





3.

Approaches to integrated food chain surveillance

Different approaches may be adopted to integrated food chain surveillance for foodborne diseases. Each country will need to structure its integrated food chain surveillance system in a way that takes into account the stakeholders involved and the location of data sources. Nevertheless, regardless of the structure chosen, there are certain elements that are common to every approach. These include:

- ✓ a team of representatives from each of the relevant sectors, who have detailed knowledge of how the data in their sector are collected;
- ✓ willingness from each sector to be involved in integrated food chain surveillance;
- ✓ clear governance structures for sharing and analysing integrated data;
- ✓ regular communication to discuss all aspects of integrated food chain surveillance;
- ✓ a clear statement of the surveillance objectives;
- ✓ a database to house the data from all the sectors participating in integrated food chain surveillance;
- ✓ regular analysis of the integrated data and publication in annual reports.

Most established integrated food chain surveillance systems were created to monitor antimicrobial resistance across the food chain. However, some systems were established principally to control and prevent foodborne diseases in humans (Galanis et al., 2012; NFI, 2014). Some models that have been used in various countries around the world are described in Box 1.

In deciding on the most appropriate approach to integrated food chain surveillance, it will be necessary to consider the human resources required, the legislative mandates of relevant authorities, and the financial resources needed to ensure long-term sustainability. Integrated food chain surveillance can be based at the national or subnational level (e.g. state or province), depending on the health system structure. The data that can be used for integrated food chain surveillance do not need to be exclusively from population-based surveillance systems. Sentinel surveillance sites can contribute data to integrated food chain surveillance, as long as they are generally representative of the broader population (either human or animal). Data from ad hoc studies can also contribute.

BOX 1.

Examples of integrated food chain surveillance systems



Example

Integrated food chain surveillance in Denmark

- The Danish Zoonosis Centre was established in January 1994 and is currently located within the National Food Institute at the Technical University of Denmark.
- Partner institutions include the Statens Serum Institut, the Danish Veterinary and Food Administration, the National Veterinary Institute and the Danish Agriculture and Food Council.
- Data are collected from all national surveillance and control programmes on zoonoses in all sectors throughout the food chain.
- A report on trends and sources of zoonoses in Denmark is published annually by the Danish Zoonosis Centre and includes summaries of foodborne outbreaks and the results of source attribution for salmonellosis, based on the integrated food chain surveillance data.

Sources: NFI (2014); Wong et al. (2004).

National Antimicrobial Resistance Monitoring System (NARMS) for Enteric Bacteria, United States of America

- NARMS was established in 1996.
- There is an interagency partnership among state and local public health departments, Centers for Disease Control and Prevention, the US Food and Drug Administration and the US Department of Agriculture.
- Changes in antimicrobial susceptibility of enteric pathogens (including foodborne pathogens) are tracked in humans, retail meats and food animals.
- Pathogens under surveillance include *Salmonella* and *Campylobacter*.
- Annual reports are published in each sector and a report from the integrated food chain surveillance system is published annually

Sources: <http://www.cdc.gov/narms/index.html>;
<http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/ucm059089.htm>

British Columbia (BC) Integrated Surveillance of Foodborne Pathogens Program, Canada

- Integrated food chain surveillance started in British Columbia in 2006.
- The agencies involved in integrated food chain surveillance include the BC Centre for Disease Control, BC Ministry of Agriculture, Public Health Agency Canada, Canadian Food Inspection Agency and the Centre for Coastal Health.

- **Salmonella isolates are collected from animal, food and human sectors and compared with each other.**
- **Representatives of the agencies involved in integrated food chain surveillance meet on a quarterly basis.**
- **There are three working groups:**
 - **laboratory – this group collects available laboratory data and compares laboratory methods;**
 - **epidemiology – this group develops surveillance objectives, a database and surveillance standards, and analyses and reports on the findings;**
 - **evaluation – this group documents successes and failures.**
- **Data come from population-based surveillance and ad hoc studies.**
- **Results are published annually.**

Sources: Galanis et al., 2012;
http://www.bccdc.ca/dis-cond/a-z/_s/SalmonellaInfection/SalmonellaAnnualReports.htm



4.

How to integrate
surveillance data across
the food chain



The development of an **integrated food chain surveillance system** that allows a better understanding of risks across the food chain implies the following:

- the existence of a team with members from each of the relevant sectors who are routinely sharing data on a regular basis;
- a governance structure that allows data to be shared, and that includes a coordination and a communication mechanism;
- the team can:
 - identify available data sources in each sector,
 - identify the appropriate pathogens for integrated food chain surveillance,
 - determine the animal species and foods to include;
- a database houses the integrated food chain surveillance data, with a data dictionary;
- a data transfer mechanism extracts data from existing surveillance databases and other data sources to send to the integrated food chain surveillance database; the mechanism specifies:
 - the type of electronic transfer (e.g. automatic feed, manually sending spreadsheets),
 - the frequency of data transmission,
 - the data fields to be sent to the database;
- a surveillance log is used to document changes in the integrated food chain surveillance system;

- **multisectoral analysis and interpretation of the integrated data including:**
 - **a data quality review process,**
 - **source attribution;**
- **data analyses are included in a regular surveillance bulletin that is available to all stakeholders;**
- **outputs from the integrated food chain surveillance system are routinely used in risk analysis;**
- **performance of the integrated food chain surveillance system is monitored using indicators;**
- **regular evaluation of the integrated food chain surveillance system.**

Each country will have to take account of its own public health infrastructure, surveillance system and priority pathogens for control. Often, antimicrobial resistance (AMR) is the starting-point for integrated food chain surveillance. Guidance for integrated food chain surveillance of antimicrobial resistance has been drafted by the WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance (AGISAR) (WHO, 2013). The principles for integrated food chain surveillance of AMR also apply more broadly to foodborne pathogens. The options described here for conducting integrated food chain surveillance are based on the AGISAR guidance and on published examples in the literature (Galanis et al., 2012; Wong et al., 2004).

In the context of the adoption of the WHO Global Plan for antimicrobial resistance by the World Health Assembly in May 2015 (WHO, 2015a) WHO Member States were urged to develop, within two years, national plans to combat antimicrobial resistance. WHO also recommends that the plans are developed using a multisectoral “One Health” approach (WHO, 2015b). A functional integrated food chain surveillance system will be a critical component of these national plans.

The process of integrating surveillance data across the food chain is often iterative, with refinements being made as the system develops. Several processes can occur in parallel, such as identifying data sources and setting the surveillance objectives. Ideally, a country may wish to cover multiple pathogens in the integrated food chain surveillance system, but may find that the available data allow surveillance of only one pathogen. The surveillance objectives will need to reflect what is possible, so that the system can meet its objectives.

Create a team

The first step is to create a team of people from the different sectors that need to be involved in integrated food chain surveillance. The team should involve both technical staff and decision-makers, as one of the first decisions will be about the best approach to conducting integrated food chain surveillance. Aspects to consider when forming the team will be the membership of the team, its governance, and the goals and objectives of integrated food chain surveillance.

Membership

It is important to ensure that all relevant partners with a stake in food safety are represented in the team, and that the roles and responsibilities of each team member are documented. Ideally, the team will be built on existing relationships from multisectoral collaboration already developed in stages 1 and 2. Integrated food chain surveillance applies mainly to microbiological hazards; chemical hazards for countries in stage 3 relate mainly to chronic health effects.

The minimum requirement for integrated food chain surveillance is to have data from animals, food and humans. The team should consist of experts from the sectors that have data that can be shared, such as:

- ✓ the human health sector (e.g. data from the surveillance and response system);
- ✓ the food safety and regulation sector, if food monitoring data are routinely collected;
- ✓ the animal health sector;
- ✓ microbiology laboratories in each sector; and
- ✓ others, such as horticulture, food technology, environmental protection and academia.

It will be necessary to engage with industry in order to undertake interventions. Depending on the team and the data available, it may be possible to involve industry from the beginning. Alternatively, it may be necessary to determine first if integrated food chain surveillance is feasible and engage with industry once some analyses have been conducted and the team has confidence in their approach. Industrial partners may also have data that they may be willing to share.

Objectives of integrated food chain surveillance

It is important for the team to agree on a set of objectives for the integrated food chain surveillance system. This will make it easier to define the governance structures that need to be in place to enable the team to share data. Some possible objectives of an integrated food chain surveillance system are given in Box 2.

BOX 2.**Examples of objectives for integrated food chain surveillance****Example**

- Monitor the occurrence of priority foodborne pathogens along the food chain.
- Identify, investigate and respond to health risks along the food chain by sharing information on human, food and animal sources.
- Formalize inter- and intra-agency partnerships required to respond to health risks along the food chain.
- Monitor the occurrence of antimicrobial resistance in bacteria isolated from food animals, food and humans.

Adapted from: Galanis et al., 2012.

Depending on the quality and timeliness of the data available, the objectives of integrated food chain surveillance can range from outbreak detection to informing policy development through the risk analysis framework.

Governance

The process of integrating food chain surveillance may start among a few key enthusiastic staff who are familiar with working together; it may therefore be quite informal. However, as the system develops, it may become necessary to formalize the governance of the system to ensure its long-term sustainability. In contrast, in some countries, it may be necessary to ensure that a formal governance structure is established before sectors come together to begin discussions.

It will be necessary to define the terms of reference for the group and ensure that the legislative mandates of each sector are respected. The terms of reference should be linked to the objectives of the surveillance system. If new positions are created for integrated food chain surveillance, job descriptions should be written to capture the role of the posts in sharing, analysing and interpreting data from the relevant sector in the context of the whole food chain. Depending on the integration model, it might be necessary to form technical subcommittees or teams to address specific aspects, such as epidemiology, laboratory testing and antimicrobial resistance.

A coordination mechanism should be established and agreed to by all parties. The mechanism will depend on the model of integration chosen. Some of the aspects to be considered when establishing a coordination mechanism are outlined in Box 3. Similarly, a mechanism for communication between team members will need to be established; this may define meeting schedules, listservers, secure websites, etc.

BOX 3.

Aspects to be considered in establishing a coordination mechanism for integrated food chain surveillance

How To



- Designate a chair to run the working group.
- Decide if there will be a roster for chairing the working group, so that each sector has the responsibility for a defined period.
- Designate a minute-taker, so that all decisions made by the working group are documented.
- Decide if there will be a roster for taking minutes at the meetings of the working group.

- Describe how the integrated food chain surveillance working group fits in existing strategic plans of each sector.
- Decide if a formal agreement to work together across the different sectors is required.
- Decide on the most appropriate formal agreement, e.g. data-sharing agreement, memorandum of understanding, Ministerial decree.

Identify data sources

In documenting the data for each sector, it is important to include routinely collected data, such as those from the human notifiable disease surveillance system and food monitoring. However, ad hoc data collections should also be considered, as they may add important insights into food–pathogen combinations. Indeed, in the initial stages ad hoc studies may be the main source of data, and can form an evidence base for expanding routine data collection, especially for food and animals.

Annex 1 contains a template that can help document the data sources to see what is available in each sector. In doing so, there are some key questions to be considered.

✔ **Where do the samples come from?**

Data from the animal sector may specify the animal species of the samples, whether the samples are from farm animals, sick or dead animals, carcasses at the slaughterhouse or the environment (e.g. animal living environments or animal feed).



Data from food monitoring may specify the type of food, where in the distribution chain it was sampled (e.g. retail, packing, distribution) and whether the food was locally produced or imported.



✔ **How often are the data collected?**

✔ **What data fields are available?**

For each of the databases in each sector, all of the data fields available should be listed. Ideally, data dictionaries for each database should be shared at this point.



✔ **Where is the database located?**

Who is the custodian of the data and who is responsible for maintaining the database?



✔ **Are there any confidentiality considerations?**

It is important that any confidentiality restrictions are respected, especially with regard to patient information.



Identify appropriate pathogens for integrated food chain surveillance

Annex 2 contains a template that countries can adapt for documenting the pathogens under surveillance in each sector. It is important to consider what information is collected routinely as part of surveillance and whether any useful data are collected on an ad hoc basis (e.g. during outbreak investigations or targeted food surveys). It might be useful also to determine if the surveillance system for specific pathogens has recently been evaluated in any of the sectors. Such evaluations might provide insights into some of the strengths of the systems that are producing data, and identify areas that may need to be addressed before integration can be considered.

The pathogens suitable for integrated surveillance are those that are tested for routinely in all sectors, that are recovered in high rates across the food chain and that can be further characterized to allow specific attribution to food sources. An important consideration when identifying pathogens for integrated food chain surveillance is whether the further characterization tests performed by laboratories in different sectors are comparable. Testing methods for food samples are quite different from those used for specimens from humans and animals. Isolates from all sectors should be further characterized using internationally recognized procedures that allow comparison between sectors. For example, if *Salmonella* is the pathogen under surveillance, it is important that the isolates from patients, food and animals are further characterized using the same tests, e.g. serotyping and pulsed-field gel electrophoresis (PFGE).


Once the first pathogen has been included in integrated surveillance, the mapping process can be revisited to determine if any other pathogens are suitable for inclusion.

Determine the animal species and foods to include


The process of documenting data collections may suggest various options for surveillance activities and some decisions will need to be made about where to focus resources and effort. It will be necessary to consider evidence from outbreak investigations about pathogen–food pairs as well as knowledge gained from work in each sector.

The main decisions that will need to be made are as follows.

✓ Which foods are to be monitored?




The selection of foods (e.g. chicken, beef, pork, fish, lamb) to be included in integrated food chain surveillance should reflect the pattern of consumption in the population. Data will be needed about the consumption of each of the food items under consideration.



It will also be important to examine which foods have been implicated as the source of infection in outbreaks and what the risk factors are for sporadic infections.

✓ Which animal species should be included?



The selection of animal species should correspond to the retail meats that are part of food monitoring programmes. It may be possible to obtain samples from farms or from the abattoirs where the animals are slaughtered.

✓ Will imported foods be included in the surveillance?

A decision will need to be made about whether imported foods should be included in the integrated food chain surveillance system. If so, information about the quantity of the food item being imported and its distribution within the food chain will be important. It may be important to involve the authorities responsible for regulating imported food, as they will most likely be responsible for implementing any necessary control measures.



Create a database

A central secure database should be created to house the data from each sector. The minimum data requirements for each sector should be defined (see Box 4) and a data dictionary created. The database will need to be able to interface with existing databases in each sector and data should be transferred electronically to avoid data entry errors and delays. In creating such a database, account should be taken of how stakeholders collect and store their data. Information technology solutions will need to be found for extracting and transmitting data to the integrated database.

All sectors involved in integrated food chain surveillance will need to agree on the data transfer mechanisms. It will be important to document:

- ✓ the type of electronic transfer (e.g. Excel spreadsheet to be manually loaded, automatic electronic transfers);
- ✓ frequency of data transmission;
- ✓ the data fields to be sent to the database.

Since the surveillance system will be developed in an iterative process, it will be important to create a surveillance log to document all the changes and refinements that are made. The surveillance log can also be a valuable tool in evaluating the surveillance system.

BOX 4.

Suggested minimum data requirements for each sector in integrated food chain surveillance

Minimum requirements



Human health

- Unique identifier
- Date of specimen submission
- Date of onset of illness
- Type of case (e.g. sporadic or outbreak)
- Appropriate laboratory characterization (e.g. *Salmonella* would require serovar and phage type/PFGE/multilocus variable tandem repeat analysis (MLVA), antibiotic susceptibility testing)

Food

- Unique identifier
- Date of sample collection
- Date of sample submission
- Date of purchase (if applicable)
- Food type (e.g. eggs, chicken, beef, pork, etc.)
- Context for collection (e.g. routine monitoring or outbreak sample)

- Location of sample collection (e.g. retail or processing plant)
- Appropriate laboratory characterization (e.g. *Salmonella* would require serovar and phage type/PFGE/MLVA, antibiotic susceptibility testing)

Animals

- Unique identifier
- Date of sample collection
- Date of sample submission
- Type of sample (e.g. faeces or environmental swab)
- Species of animal from which the sample was collected
- Context for collection (e.g. routine monitoring, diagnostic samples for sick or dead animals, outbreak investigation)
- Location of sample collection (e.g. farm, abattoir)
- Appropriate laboratory characterization (e.g. *Salmonella* would require serovar and phage type/PFGE/MLVA, antibiotic susceptibility testing).

Multisectoral data analysis and interpretation

It may take some time to refine multisectoral analysis and interpretation of the data to a point that ensures that all sectors are confident about integrated food chain surveillance. The frequency of analysis, the outputs from the analysis, data quality review and multisectoral interpretation are the main points to consider.

Determine the frequency of analysis

The frequency of analysis will depend on how often data are transmitted from each sector to the integrated database. If one of the objectives of the surveillance system is to detect outbreaks, it will be important to ensure that data are being collected, transmitted and analysed rapidly.

Determine the standard data analyses

Data from the database need to be analysed with input from all partners in the team, to provide context for data collection in their sector. A data analysis plan will need to be developed in the early stages of integrated food chain surveillance. Some analyses that might be included are:



(for human data) serotype and month,



(for animal data) serotype and month,



(for food data) serotype and month,



(for integrated data) serotype by source (human, animal species and food commodity) over a defined period,



(for integrated data) phage type/AMR pattern/PFGE/MLVA by sector (human, animal, food),



(for integrated data) graphs of isolates by month and sector for each of the three most common serotypes.

Data can be analysed for each sector and across the food chain, to look for clustering of common strains over time. If one of the objectives of integrated food chain surveillance is to detect outbreaks, epidemiological criteria will need to be defined for clustering that warrants further investigation, e.g. identification of the same strain in all three sectors over a certain period of time. Several years of data analysis may be needed to provide a baseline for the integrated food chain surveillance system, before clustering can be defined.

As the integrated food chain surveillance system develops, it will be possible to consider more complex analyses. One of the main analyses that can be conducted using data from integrated food chain surveillance is source attribution. This uses mathematical models (Hald et al., 2004; Pires & Hald, 2010) to determine the proportion of illness due to a particular pathogen that can be attributed to particular food sources. Source attribution can be attempted if (a) data are collected in a timely and consistent fashion in each sector, (b) there are uniform laboratory typing methods in each sector, and (c) there is a large enough range of food and animal samples. It is also important that the human surveillance database can capture information about whether each case was:

- ✓ part of an outbreak or a sporadic case;
- ✓ acquired locally or overseas.

The results of source attribution can be used by risk managers and policy-makers to develop control programmes and evaluate existing interventions along the food chain. Guidance on conducting source attribution is available elsewhere (European Food Safety Authority, 2008).

Develop a data quality review process

Since data will be entering the integrated database from multiple sources, there needs to be a dedicated process for cleaning the data. Each data source will have differently coded data and different definitions. Time will have to be spent going through the data from each sector to ensure there are no duplicates and that the data can be made uniform for analysis. This will be particularly important when surveillance is first established. Over time, it may be possible to develop automatic quality checks and translate data into the correct format during transmission. All sectors should be involved throughout the process to ensure that the integrity of their data is maintained.

Multisectoral interpretation

Multisectoral interpretation of the data is vital to ensure that valid conclusions are being drawn from the analyses. Each sector has an in-depth understanding of the context in which their data are collected and knows their limitations. Involving all sectors in the interpretation reduces the likelihood that incorrect assumptions will be made about the data. It will also help ensure that patterns in the data can be explained and understood by each sector.

Surveillance bulletin

As with any surveillance system, it is important that the analyses are published in a surveillance bulletin. The bulletin should include:

- ✓ the data collection methods in each sector (e.g. notification, targeted ad hoc studies, food monitoring programmes);
- ✓ data from each sector to provide the context for the issue in humans, food and animals;
- ✓ integrated analysis, showing the data from each sector considered together over the same time period.

Table 1 lists examples of bulletins produced from integrated food chain surveillance systems.

TABLE 1.

Examples of surveillance bulletins for foodborne diseases

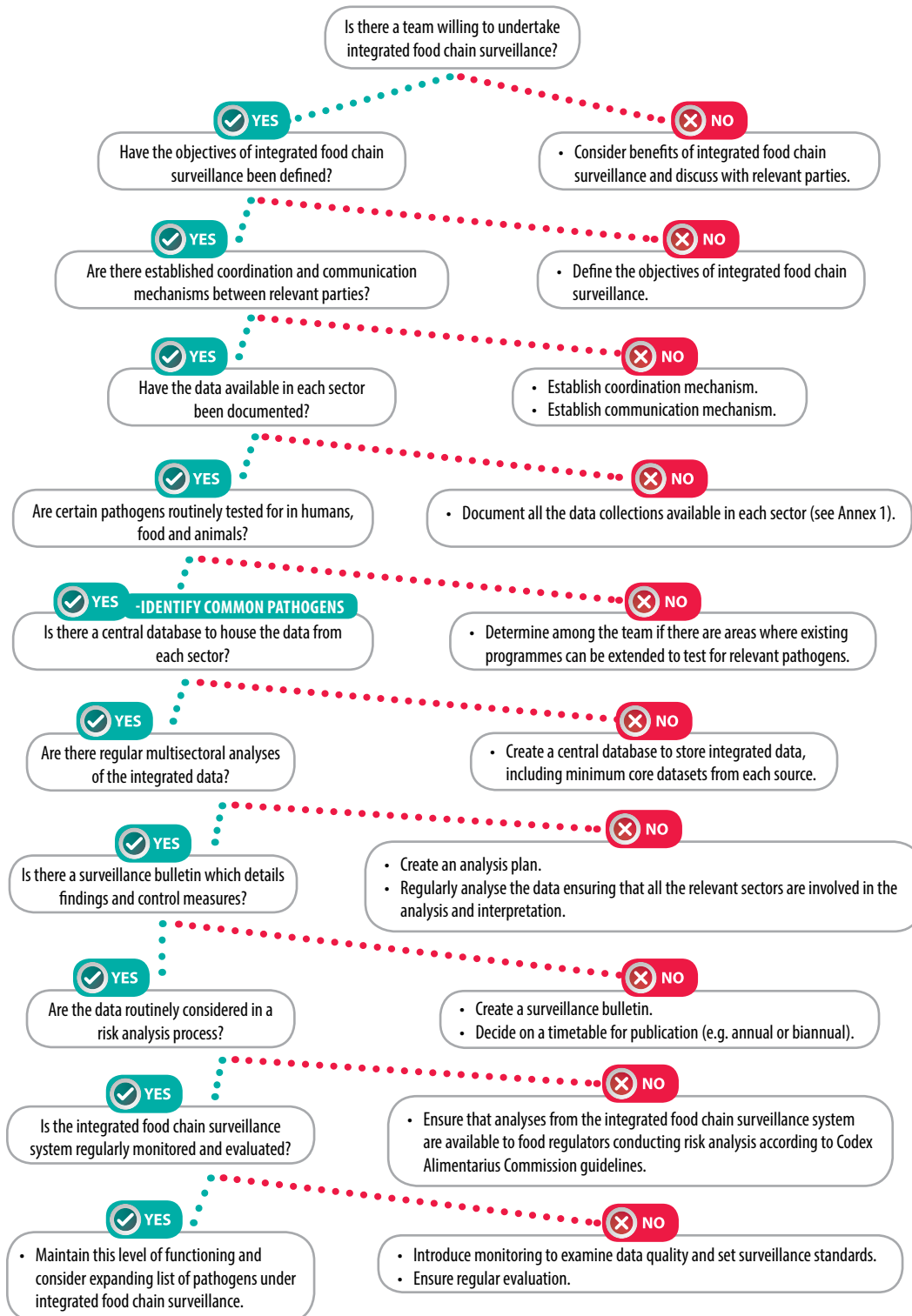
Example surveillance bulletins	Weblink
British Columbia Integrated Surveillance of Foodborne Pathogens: <i>Salmonella</i> findings	www.bccdc.ca/integratedfoodchainsurveillance
DANMAP: Danish Integrated Antimicrobial Resistance Monitoring and Research Programme	http://www.danmap.org/Downloads/Reports.aspx
Annual Report on Zoonoses in Denmark	http://www.food.dtu.dk/english/Publications/Food-safety/Zoonosis---annual-reports

(TABLE 1. Continue)

Example surveillance bulletins	Weblink
The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks (EFSA/ECDC)	http://www.efsa.europa.eu/en/efsajournal/doc/3991.pdf
NARMS: National Antimicrobial Resistance Monitoring System for Enteric Bacteria (USA)	http://www.fda.gov/downloads/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/UCM407962.pdf

Figure 2 summarizes the steps a country can take to integrate the surveillance of foodborne diseases across the food chain.

Decision-tree to identify the steps a country can take to undertake integrated food chain surveillance in stage 3





5. Risk analysis

Risk-related terms and how they are used in the surveillance and response sector and the food safety sector are discussed in Annex 2 of the introductory module to this manual.

One of the purposes of integrating data sources across the food chain is to allow risks along the food chain to be considered in a continuous risk analysis framework. Risk analysis is used to estimate the risks to human health and safety, identify and implement appropriate measures to control the risks, and communicate with stakeholders about the risks and control measures. Guidance on conducting risk analysis has been published elsewhere (FAO/WHO, 2006).

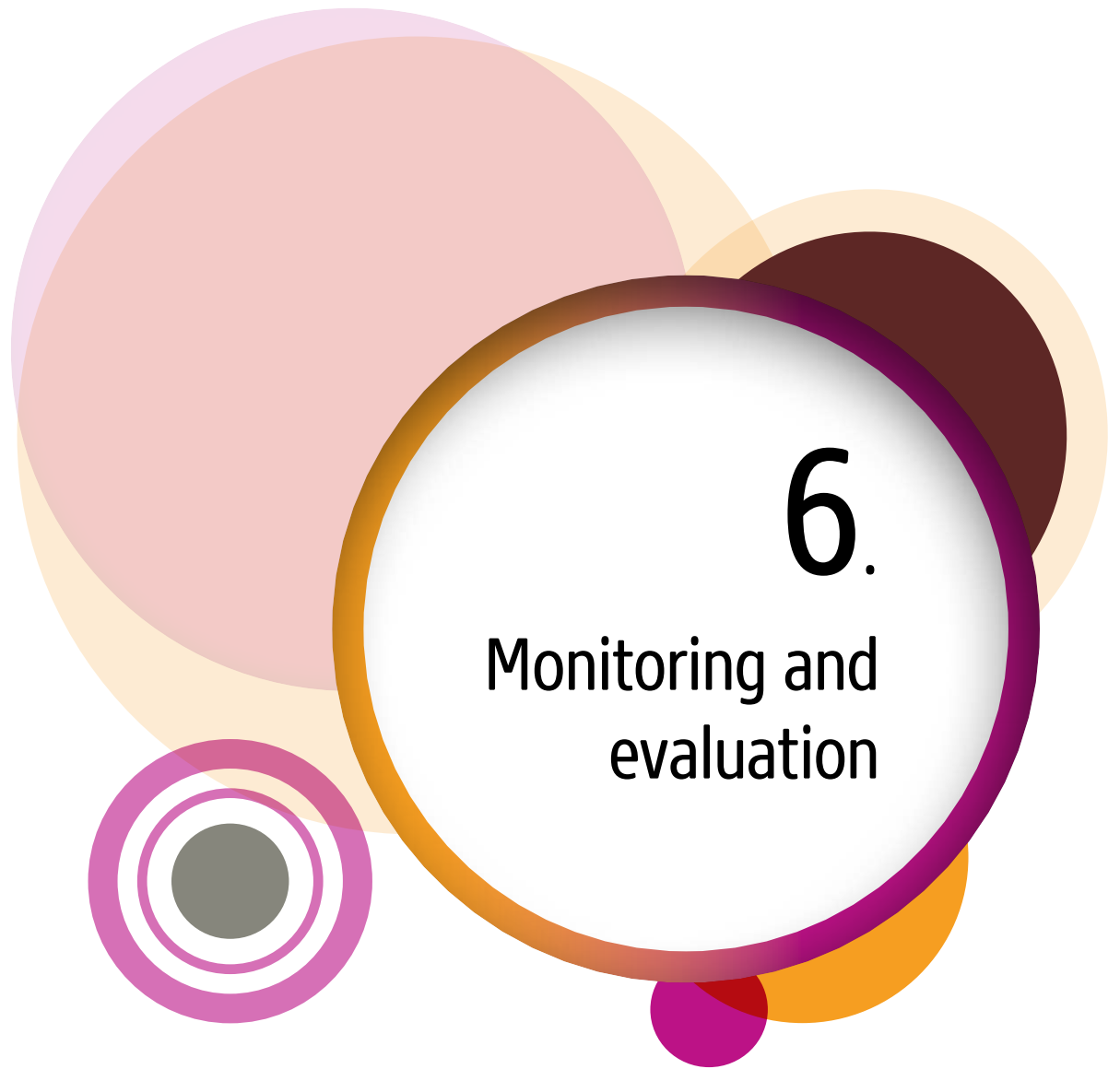
The risk analysis process involves the following components (FAO/WHO, 2006; FAO/WHO, 2014).

- **Risk assessment.** The qualitative or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse health effects in a given population based on hazard identification, hazard characterization and exposure assessment. Data and information from the surveillance and response system for foodborne diseases are used primarily in this step (mainly for hazard identification and exposure assessment).
- **Risk management.** The process, distinct from risk assessment, of weighing policy options in consultation with all interested parties, taking into consideration the risk assessment and other factors relevant to protecting the health of consumers.
- **Risk communication.** The interactive exchange of information and opinions throughout the risk analysis process concerning hazards and risks, risk-related factors and risk perceptions, among risk assessors, risk managers, consumers, industry, the academic community and other interested parties. It includes the explanation of risk assessment findings and the basis of risk management decisions.

In order to undertake risk analysis, the following should be in place (FAO/WHO, 2006):

- 📌 an operating food safety system:
 - food laws, policies, regulations and standards;
 - efficient food safety and public health institutions (i.e. a surveillance and response system);
 - mechanisms for coordination between food safety and surveillance and response sectors;
 - operational food inspection and laboratory services;
- 📌 capacities for risk analysis:
 - decision-makers at policy and operational levels who understand risk analysis;
 - scientific capacity to carry out risk assessments;
 - ability to engage with key stakeholders, such as consumers, industry and academics.

It is crucial that the risk analysis process follows a structured process, is transparent and fully documented, and that all aspects of the process are clearly communicated to consumers and other interested parties along the food chain. One output of the risk analysis process is the communication of the risks posed by specific hazards in different food items. The results of risk analysis should be made public as they become available.



At all stages of strengthening surveillance and response for foodborne diseases, routine monitoring and regular evaluations can help to ensure that the system is functioning efficiently and effectively. The monitoring system should be fully functional in stage 2. As a country moves to stage 3, new indicators that specifically address integrated food chain surveillance will need to be introduced. The integrated food chain surveillance system will also need to be evaluated regularly to ensure that it is meeting its objectives.

Guidance on monitoring and evaluation for disease surveillance and response systems already exists (WHO, 2006; Centers for Disease Control and Prevention, 2001). WHO (2006) has proposed indicators for monitoring and evaluation and provided tools for compiling data for monitoring purposes. Specific guidance on evaluation and monitoring for the early warning function of EBS and IBS has also been published (WHO, 2014), and can be applied to integrated food chain surveillance. It is important that the data from the human health sector are suitable for sharing and that the staff sharing the data are aware of any issues in the surveillance and response system.

Monitoring

It will be necessary to develop indicators for integrated food chain surveillance for monitoring purposes (Annex 3). The monitoring indicators should be applied to each data source and to the overall integrated food chain surveillance system.

Evaluation

A number of factors should be considered in evaluating an integrated food chain surveillance system. The attributes of the surveillance system can be evaluated using existing guidance (WHO, 2006; Centers for Disease Control and Prevention, 2001), but consideration will also need to be given to the governance and long-term sustainability of the system. For example, it may be necessary to survey the various sectors involved in integrated food chain surveillance to determine if they have encountered any challenges in contributing or analysing data as a result of limitations in the governance structure. If issues are identified, the governance structure should be reviewed and, if necessary, modified. The time and human and financial resources needed to support integrated food chain surveillance should also be analysed to determine whether it is sustainable. The successes of integrated food chain surveillance should also be documented, e.g. early detection of disease clusters and prompt initiation of control activities.



7. Managing implementation

There are several steps a country can take to implement the guidance contained within this module.

Decision-trees

Use the decision-tree presented in this module to assess existing capacities and determine what actions still need to be taken to implement integrated food chain surveillance. Annex 4 lists all the actions from the decision-tree, and contains a template for recording the information.

It is important to note that the stages and the capacities in the decision-tree 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 2 before moving to stage 3. It may be necessary to cross-refer to the stage 2 module regarding development of remaining capacities for stage 2.

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 identifying priority activities for implementation include:



impact on the integrated food chain surveillance system;



available resources (e.g. financial and human);



ease of implementation.

The priorities can be documented for each capacity-building activity in the template in Annex 4.

Ideally, countries should give priority to activities that will increase the impact of the surveillance and response system and that can be implemented within the available financial and human resources. However, some capacities will require significant investments; the information in this module may be used in drafting proposals for funding for the integrated food chain surveillance system.

Strategic plans

It is important to have a strategic plan for integrated food chain surveillance, to ensure that all key stakeholders have a clear vision of the system and to identify the priorities for further development. Developing an integrated food chain surveillance system is an iterative process and a long-term view is needed. Formulating a plan can assist in:



articulating a long-term strategy for sustainability of the system;



ensuring that limited resources are not wasted on activities that do not meet the objectives of the surveillance system.

An outline of a national strategic plan for integrated food chain surveillance is given in Box 5.

BOX 5.

Outline of a national strategic plan for integrated food chain surveillance: NARMS Strategic Plan 2012-2016 (USA)



How To

The NARMS Strategic Plan 2012-2016 is a 10-page document, which is structured as follows:

1. Mission

NARMS is a national public health surveillance programme that monitors the susceptibility of enteric bacteria to antimicrobial agents of medical importance, in order to help assess the impact of veterinary antimicrobial use on human health.

2. Overview of accomplishments, 1996-2011

3. Strategic goals and objectives

Under each goal, a set of objectives is listed. The goals are:

1. Develop a sampling strategy that is more representative of food animal production and consumption and more applicable to trend analysis.
2. Optimize data acquisition, analysis, and reporting.
3. Strengthen collaborative research projects.

4. Collaborate with international institutions that promote food safety, especially those focused on mitigating the spread of antimicrobial-resistant bacteria.

4. Challenges and opportunities

5. Conclusion

Source:<http://www.fda.gov/downloads/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/UCM236283.pdf>



Annex 1.

Documenting data
collections across
the sectors

The template below can be used to obtain an overview of the data available in each sector. Each sector should list all the data collections that it would be willing to share and describe the data available, i.e. the variables included in the database. Examples are provided in italics. The process of completing the template can help identify gaps and, more importantly, which data collections are suitable for integration.

Question	Human health	Food	Animal	Other relevant data sources
<i>Routine data collection</i>				
<i>What is the name of the database and where is it located?</i>	<i>Notifiable disease surveillance system; communicable disease area of the Health Department</i>	<i>Retail food monitoring system; food safety area of the Health Department</i>	<i>Abattoir surveillance programme; meat hygiene area of Agriculture Department</i>	<i>Laboratory information management system; Public Health Laboratory</i>
<i>Where do the samples come from?</i>	<i>Clinical isolates collected from symptomatic people by health care providers</i>	<i>Routine collection of chicken and beef mince from the retail level</i>	<i>Two major abattoirs that process chickens; one abattoir that processes cattle, pigs, sheep and goats</i>	<i>The laboratory processes samples from the health and food sectors, as listed; isolates collected from industry as part of quality assurance programmes</i>
<i>How often are the data collected?</i>	<i>Ongoing</i>	<i>Once a month, 20 retail samples of chicken and 20 retail samples of beef mince</i>	<i>Chicken: once a month 20 carcasses are taken for testing Cattle, pigs, sheep and goats: once a month swabs are taken from 10 carcasses of each type of animal</i>	<i>As required</i>
<i>What data fields are available (list all of the variables in the database)?</i>	<i>Date of birth Residential suburb Name of laboratory-confirmed pathogen Date of illness onset Date of specimen collection Date of notification Sporadic/outbreak case etc.</i>	<i>Food product sampled Brand of food product Place of purchase of food product Date of sample collection Name of laboratory-confirmed pathogen Date of laboratory result etc.</i>	<i>Animal type sampled Type of sample (e.g. carcass or swab) Abattoir Date of sample collection Name of laboratory-confirmed pathogen Date of laboratory result etc.</i>	<i>Type of sample (e.g. human, food type, environmental swab, etc.) Name of laboratory-confirmed pathogen Date of submission to the laboratory etc.</i>

(TABLE Continue)

Question	Human health	Food	Animal	Other relevant data sources
Are there any confidentiality considerations?	Yes, medically confidential data. Name, address and contact details will not be available	No	No	Yes, the origin of industry samples is commercial-in-confidence
Ad hoc data collection				
Why were the data collected and where is the database located?	Event database; communicable diseases area of Health Department	Targeted food survey in response to outbreaks; food safety area of Health Department	Targeted survey designed to measure Salmonella presence in broiler flocks; animal health area of Agriculture Department	
When were the data collected?	Ongoing, the event database is updated quarterly	Jan-Feb 2015 during a Salmonella outbreak	Jan-Dec 2014	
What data fields are available (list all of the variables in the database)?	Date investigation commenced Number of human cases Number of hospitalizations Number of deaths Name of laboratory-confirmed pathogen Number of cases laboratory-confirmed Food source identified Level of evidence etc.	Sample type (e.g. environmental swab, food sample) Food type (e.g. prepared food item, raw ingredients) Name of laboratory-confirmed pathogen Date of sample collection Date of laboratory result etc.	Date of sample collection Type of sample (e.g. chicken faeces, litter environment, feed sample, water sample) Name of laboratory-confirmed pathogen etc.	



Annex 2.

Documenting pathogens
under surveillance in each
sector

The template below can be used to obtain an overview of the pathogens under surveillance in each sector and to identify common pathogens, which can then be the focus of integrated food chain surveillance.



How To

- 1. To use this tool, list each pathogen and the laboratory methods used for testing.**
- 2. Put a cross in the appropriate column for each sector, depending on whether the data are collected routinely or on an ad hoc basis.**
 - a. Routine data collection: data are collected regularly and in a systematic way, e.g. through the notifiable disease surveillance system for humans and animals, or pathogens routinely tested for in food samples.
 - b. Ad hoc data collection: data that are not collected regularly. These may be from one-off food surveys, samples collected during outbreak investigations, or targeted research, such as source attribution studies.
- 3. Identify the pathogens that are tested for routinely in all three sectors and are characterized to a sufficient level to allow illness in humans to be attributed to specific food types.**

Pathogen	Testing method	Human health sector		Food sector		Animal health sector	
		Routine	Ad hoc	Routine	Ad hoc	Routine	Ad hoc
Salmonella							
	Nucleic acid testing						
	Culture						
	Serotyping						
	Phage typing						
	MLVA						
	PFGE						
	Whole genome sequencing						
	Antibiotic susceptibility testing						
Campylobacter							
	Nucleic acid testing						
	Culture						
	MLST						
Shiga-toxin-producing E.coli							
	Nucleic acid testing						
	Culture						
	Serotyping						
	Whole genome sequencing						



Annex 3.

Examples of monitoring
indicators for foodborne
diseases

Some example indicators for monitoring of the surveillance and response system for foodborne diseases in stage 3 are given in Table A3.1.

TABLE A3.1.

Example indicators for monitoring the surveillance and response system for foodborne diseases in stage 3

Proposed indicator	Numerator	Denominator
Proportion of all team members whose job description mentions role of formally contributing to integrated food chain surveillance	Number of people in the integrated food chain surveillance team whose job description mentions their role	Total number of people in the integrated food chain surveillance team
Data completeness for fields in minimum core data set in each sector	The number of valid entries that adhere to the data specifications for the data field	Total number of entries for the data field
Annual publication of surveillance report	N/A	N/A
Number of specific control measures undertaken in response to data from the integrated food chain surveillance database	N/A	N/A

N/A= not applicable



Annex 4.

Managing implementation

The template below summarizes the capacities to be strengthened in a surveillance and response system for foodborne diseases in stage 3. This template can be completed to provide an overview of the current situation and help identify the priority capacities for strengthening.

How To



- 1. Each row in the template corresponds to a point in the decision-tree given in section 4. Refer to the decision-tree and the accompanying text for more explanation.**
- 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:**
 - a. impact:* the impact of the activity on the surveillance and response system for foodborne diseases: rate as high, medium, low, or no impact;
 - b. resources:* the resources (e.g. financial and human) required for implementation of the activity; rate as high, medium, low, or no resources;
 - c. ease:* the ease with which the activity can be implemented; rate as easy, neutral or difficult.
 - d. priority:* based on the impact, resources and ease of implementation, assign a priority to the capacity-building activity; rate on a scale from 1 (low priority) to 5 (high priority); 0=not a priority.

- 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 the implementation activity.**

Capacities	Capacity exists (yes/no)	Priority for implementation ^a				Actions	Timeframe	Person responsible
		Impact	Resources	Ease of	Priority			
There is a team with members from each of the relevant sectors who are sharing data								
The governance structure allows data to be shared and includes: <ul style="list-style-type: none"> a coordination mechanism a communication mechanism 								
Data sources for integration have been identified								
Pathogens for integration have been identified								
Animal species and food items to be included in the surveillance system have been identified								
There is a database to house the integrated food chain surveillance data, with a data dictionary to support its operation								

Capacities	Capacity exists (yes/no)	Priority for implementation ^a				Actions	Timeframe	Person responsible
		Impact	Resources	Ease of	Priority			
There is a data transfer mechanism, which specifies: <ul style="list-style-type: none"> • type of electronic transfer; • frequency of data transmission; • data fields to be sent to the database. 								
A surveillance log documents changes to the integrated food chain surveillance system								
Multisectoral analysis and interpretation of the surveillance data are carried out, and include: <ul style="list-style-type: none"> • a data quality review process; • source attribution. 								
Analyses are regularly published in a surveillance bulletin								
Outputs from the integrated food chain surveillance system are used in risk analysis								
Monitoring indicators have been developed for integrated food chain surveillance								
The integrated food chain surveillance system has been evaluated in the previous 5–10 years								

^a 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.



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