Animal Health Surveillance Terminology Final Report from Pre-ICAHS Workshop

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Introduction

This document provides definitions of general animal health surveillance related terms and lists of characteristics that can be used to describe surveillance activities and attributes that are useful to evaluate these activities. The aim of producing this summary of animal health surveillance terminology is to facilitate communication between those commissioning, designing, implementing and contributing to surveillance activities. This will provide a common understanding of these different surveillance activities so that they can be clearly described. Agreed descriptions of surveillance activities will facilitate comparison and evaluation of these activities thus contributing to the design of appropriate surveillance systems for different surveillance purposes and situations.

The terminology proposed in this document has been developed based on the terminology used by others in both the public and animal health fields (see reference list) as well as in discussions at two international animal health surveillance workshops held in August 2009 and May 2011. The definitions included in this document are based on those developed at the second of these workshops which was held prior to the International Conference on Animal Health Surveillance (ICAHS) in May 2011. These definitions were then modified based on comments received from workshop participants (appendix 1) and others with an interest in animal health surveillance methods (appendix 2). The definitions were then reviewed by individuals or groups from different countries and disciplines (appendix 3) to identify any inconsistencies between the definitions proposed and those currently used in their country or field of expertise. The first version of this report was produced and distributed on the ICAHS and Animal Health and Veterinary Laboratories Agency (AHVLA) websites in December 2011. A further review of the definitions included in the report was carried out during the production of an article for Preventive Veterinary Medicine (PVM) to describe the methods used to develop these definitions and a discussion of the decisions made. This version of the report was distributed in July 2013 based on the revisions made during the production of the article for PVM. Some ideas from the results of ongoing discussions about surveillance terminology that have taken place as part of an EU funded collaborative project (RISKSUR) were also incorporated. The discussions within this project are likely to inform further improvements in the definitions of surveillance related terms. The ICAHS conference in May 2014 would provide an opportunity to review and update the definitions included in this document based on the work being carried out in RISKSUR and incorporating contributions from others with an interest in surveillance terminology.

The document is designed as a reference document including detailed definitions for a variety of terms that have been used in the animal health surveillance field. Only a selection of these definitions may be required by individual users and these may need to be adapted to suit their own circumstances or needs. This document provides a summary of how others in the animal health surveillance field are using these terms, the intention being to provide a comprehensive summary of the terms that are currently used to enhance understanding and reduce confusion. Any remaining inconsistencies in the use of these terms which were identified at the workshop or in subsequent reviews have been highlighted in footnotes.

1. Definitions of general surveillance terms used in animal health surveillance

Animal health surveillance provides essential information to allow action to be taken to protect animal health and welfare. This is also closely linked with the protection of human health. In addition the detection of hazards in human populations may contribute to the detection of hazards in animal populations. This close link between animal and public health surveillance has been acknowledged in the 'one health' initiative.

This section of the document first provides definitions of surveillance and monitoring. There are many existing definitions of surveillance[1,2,3] all of which are very similar; we have adapted these to provide a definition which includes all the important features of animal health surveillance. The health-related data referred to in this definition of surveillance can be collected directly from animal populations but also, as indicated above, from human populations and from other sources including biological and mechanical vectors and environmental sources. After providing these initial definitions for surveillance and monitoring various different types of surveillance are defined.

1.1 Surveillance[a, b]

The systematic, continuous or repeated, measurement, collection, collation, analysis, interpretation and timely dissemination of animal health and welfare related data from defined populations. These data are then used to describe health hazard occurrence and to contribute to the planning, implementation, and evaluation of risk mitigation actions[c].

1.2 Monitoring[d, 4]

The systematic, continuous or repeated, measurement, collection, collation, analysis and interpretation of animal health and welfare related data in defined populations when these activities are not associated with a pre-defined risk mitigation plan although extreme changes are likely to lead to action.

Notes

[a] It is not always clear which activities should be classified as surveillance, it has been suggested that a distinction should be made between risk mitigation (control) activities and surveillance activities. However, many risk mitigation programmes have a surveillance component as well as an intervention component. These surveillance components of mitigation programmes often provide information that is consistent with this definition of surveillance i.e. it is continuously collected, provides descriptive information and is linked with action so the surveillance components of these mitigation programmes can be classified as surveillance activities. In addition other activities which do not satisfy this definition (particularly surveys but also analytical studies) may provide information about the level or distribution of health hazards so may need to be considered together with surveillance activities in some circumstances but these are not considered to be surveillance activities.

[b] Other closely related terms include biosurveillance[5] which is focussed on the detection and investigation of disease outbreaks and 'biosecurity surveillance'[6] which is used to describe surveillance of animal and plant populations in New Zealand with a focus on the detection of disease incursions

[c] In France the two objectives of animal health surveillance are risk evaluation (included as describing health hazard occurrence in our definition) and risk management (included as planning, implementation and evaluation of risk mitigation measures in our definition).

[d] Monitoring is a controversial term which has been defined in various ways, some of those working in animal health surveillance believe this is a redundant term and that the collection of animal health related data without a clear related action plan should not be encouraged. If the term monitoring is used then some of the terms used to describe different types of surveillance could also be used to describe different types of monitoring e.g. hazard-specific monitoring or sentinel monitoring.

1.3 Different types of surveillance

1.3.1 Early warning surveillance[e] (epidemiological watch[7], epidemiovigilance)

Surveillance of health indicators and diseases in defined populations to increase the likelihood of timely detection of undefined (new) or unexpected (exotic or re-emerging) threats. These are surveillance systems for the early detection of these threats.

1.3.2 Indicator-based surveillance

Traditional disease surveillance which relies on the collection of data about the occurrence of pre-defined diseases or conditions and which uses agreed-upon case definitions; these data are analysed to produce indicators that point towards the existence of a threat. Indicator-based surveillance may be hazard-specific or general and includes the use of clinical or other data for syndromic surveillance.

1.3.3 Hazard-specific surveillance[f]

Surveillance that is focused on one or more pre-defined hazards (disease, condition, biological, chemical or physical agent, or event) often this form of surveillance uses diagnostic tests for the detection of particular pathogens (e.g. molecular diagnostic methods).

1.3.4 General surveillance

Surveillance that is not focused on specific hazards and uses general tests (e.g. clinical examination or gross pathology). Syndromic surveillance is a form of general surveillance.

1.3.5 Syndromic surveillance[1,8,9,10, g]

Surveillance that uses health-related information (clinical signs or other data) that might precede or substitute for formal diagnosis. This information may be used to indicate a sufficient probability of a change in the health of the population to deserve further investigation or to enable a timely assessment of the impact of health threats which may require action. This type of surveillance is not usually focused on a particular hazard so can be used to detect a variety of diseases or pathogens including new (emerging) diseases. This type of surveillance is particularly applicable for early warning surveillance.

1.3.6 Event-based (media-based, digital) surveillance[11, h]

Surveillance that complements indicator-based surveillance by continuously scanning the Internet and other communication media to detect information that might lead to the recognition of emerging threats. It uses unstructured data which need to be studied and verified and which cannot be summarised as an indicator.

Notes

[e] Early warning surveillance was previously known as 'scanning surveillance' in the United Kingdom, this was defined as ''monitoring the health of an animal population to detect the undefined or unexpected in a timely way' and described the approach taken to early warning surveillance in this country and may still be used locally but is not widely used outside the UK[12]

[f] Hazard-specific surveillance has previously been called 'targeted surveillance'[12]. We have avoided the use of the term 'targeted surveillance' in this document because this term has also used to describe what we have defined in this document as 'risk-based surveillance'. In addition what we have defined as 'hazard-specific surveillance' is defined in the OIE terrestrial code as 'specific surveillance'[2] although this may be changed to 'pathogen-specific surveillance'

[g] The use of the term syndromic surveillance is sometimes restricted to describe only those activities that use clinical data to define syndromes with 'indirect surveillance' being used for activities that rely on the use of other data sources (e.g. drug sales)

[h] In France the term 'surveillance evenementelle' which could be translated as 'event-based surveillance' has been used to mean what we are defining in this document as passive surveillance. In addition the term 'media-based surveillance' has been suggested as a more appropriate description of what has been defined here as 'event-based' surveillance and the term 'digital' surveillance has recently been used to describe this type of surveillance[29]

1.3.7 Risk[j]- based surveillance[13, k]

Use of information about the probability of occurrence and the magnitude of the biological and/or economic consequence of health hazards to plan, design and/or interpret the results obtained from surveillance systems. Risk-based surveillance can include one or several of the following four approaches:

- Risk-based prioritisation
- Risk-based requirement
- Risk-based sampling
- Risk-based analysis

1.3.7.1 Risk[j]- based prioritisation[14]

Determining which hazards should be selected for surveillance based on information about the probability of their occurrence and the extent of biologic and/or economic consequences of their occurrence.

1.3.7.2 Risk[j]-based requirement[15,16]

Use of prior or additional information about the probability of hazard occurrence to revise the surveillance intensity required to achieve the stated surveillance purpose.

1.3.7.3 Risk[j]- based sampling[17,18,19, k]

Designing a sampling strategy to reduce the cost or enhance the accuracy of surveillance by preferentially sampling strata (e.g. age groups or geographical areas) within the target population that are more likely to be exposed, affected, detected, become affected, transmit infection or cause other consequences[m] (e.g. large economic losses or trade restrictions).

1.3.7.4 Risk [j]- based analysis

Use of prior or additional information about the probability of hazard occurrence, including contextual information and prior likelihood of disease to revise conclusions about disease status

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1.3.8   Sentinel surveillance[1, o]

The repeated collection of information from the same selected sites or groups of animals (e.g. veterinary practices, laboratories, herds or animals) to identify changes in the health status of a specified population over time. These sentinels should act as a proxy for the larger population of interest; they may be selected on the basis of risk but can also be selected randomly or on the basis of convenience or compliance.

1.3.9   Active (proactive) surveillance[p]

Investigator-initiated collection of animal health related data using a defined protocol to perform actions that are scheduled in advance. Decisions about whether information is collected, and what information should be collected from which animals is made by the investigator.

1.3.10   Passive (reactive) surveillance[p]

Observer-initiated provision of animal health related data (e.g. voluntary notification of suspect disease) or the use of existing data for surveillance. Decisions about whether information is provided, and what information is provided from which animals is made by the data provider.

1.3.11   Enhanced passive surveillance[p]

Observer-initiated provision of animal health related data with active investigator involvement e.g. by actively encouraging producers to report certain types of disease or by active follow up of suspect disease reports.

1.3.12   Participatory surveillance[q]

Participatory surveillance explores traditional information networks by using participatory rural appraisal methods such as ranking, scoring and visualisation techniques to conduct risk-based, hazard-specific surveillance. The approach uses semi-structured interviews with key informants. This enables communities to provide their knowledge regarding health events, risks, impacts and control opportunities by gathering qualitative health data from defined populations. The analysis of participatory data emphasises the comparison of information obtained from multiple informants; the method uses a variety of techniques to obtain the most likely interpretation of events. The objective is to enhance sensitivity by identifying cases based on a clinical case definition; these may then be evaluated and confirmed using either rapid tests in the field or laboratory diagnostics. Conventional epidemiological investigation techniques can be used to evaluate and confirm outbreaks detected by participatory surveillance as part of trace-back and trace-forwards activities.

Notes

[o] Sentinel surveillance is related to the use of sentinel animals, the latter are indicator animals, often highly susceptible to the disease of interest, which are included in a population to detect the occurrence of low incidence diseases. Sentinel animals may be used in a sentinel surveillance system but not all sentinel surveillance systems involve the use of sentinel animals. The term 'pointed site surveillance' is used in China to mean what we are defining here as 'sentinel surveillance'

[p] In France the term 'surveillance evenementelle' which could be translated as 'event-based' or 'occurrence- based' surveillance has been used to mean what we are defining in this document as passive surveillance and the term 'surveillance programme' which could be translated as 'planned' or 'programmed' surveillance has been used to mean what we are defining in this document as active surveillance. In addition not all countries distinguish 'enhanced passive' surveillance components from 'passive' surveillance components. Finally, the term **enhanced passive** can be used in two ways. As well as its use here to describe enhanced passive surveillance **components** it is also used to describe enhanced passive surveillance **systems** that enhance the value of passively collected data by integration, analysis and dissemination of multiple data sources. This type of surveillance is particularly useful for the detection of new (emerging) disease but can also contribute to other surveillance purposes (e.g. exotic disease detection).

[q] Participatory surveillance is a new methodology based on participatory rural appraisal methods which is currently being applied in a variety of settings. This definition was developed by the ICHAS workshop participants with contributions from a number of experts with a range of field experience in using these methods. Participatory surveillance has previously been known as participatory disease surveillance (PDS).

2. Characteristics used to describe surveillance activities

Table 1 lists the characteristics that can be used to describe surveillance activities. These characteristics are divided into five groups to indicate which aspect of the surveillance system they describe. The suggested options for each characteristic are summarised in this table and listed and defined in more detail in tables 2-6. The characteristics in the shaded boxes are those that were considered to be most useful for describing surveillance activities by those attending the pre-ICAHS workshop in May 2011 or those commenting subsequently.

Table 1: Surveillance description characteristics (most useful characteristics in shaded boxes)

Group	Description characteristics within this group	Options available for description characteristics
2.1 Aim of surveillance	Surveillance purpose	Early detection, substantiate freedom, describe baseline level, distribution and impact, describe health changes, describe changes that threaten health, detect cases
	Policy purpose	Manage outbreak, inform trade, prioritisation, inform control
	Expected outcome	
	Anticipated actions taken	
2.2 Organisation	Scope of surveillance activity	Component, system, network, program(me), plan, portfolio
	Unit of interest	e.g. animal, farm, batch, village
	Stakeholders – owners and beneficiaries	
	Management – personnel and organisational structure	
	Relationship with mitigation activity	Integrated, autonomous
	Basis of participation	Voluntary, voluntary recruitment with mandatory participation, mandatory
	Year started	
	Units examined per year	
	Associated legislation and regulations	
2.3 Population included	Geographical area included	Local, provincial, national, regional, international
	Species / breed	
	Whether sampling is risk-based and basis of the risk-based sampling	Based on probability of exposure, becoming affected, being affected, being detected, transmission, other consequences
	Sampling strategy	Census, random, systematic, convenience, haphazard, purposive, volunteer, event-related, participant recommend
	Population stream	Healthy live, healthy cull, sick live, sick cull, dead
	Age	
	Livestock sector	
2.4 Disease of interest	Disease focus	Hazard-specific, general
	Name(s) of health hazard(s)	
	Pattern of disease occurrence	Endemic, sporadic, exotic, re-emerging, new
	Disease present	Present, absent, not known
	Disease mitigation stage	Sustainment, investigation, implementation
	Whether disease is generally considered to be zoonotic	Yes, no, insufficient knowledge
2.5 Information management	Origin of data	Active, passive, enhanced passive
	Data collection method	e.g. postal, telephone, visit, internet, focus group
	Study design	Case reports, survey, continuous collection, sentinel, participatory, event-based (media-based)
	Case definition	Clinical signs or syndrome, indirect indicators, gross pathology, lab tests for pathogens or host response, specified diagnostic criteria, risk factors
	Data analysis method	
	Who is data provided by	
	Location of data collection	
	Who is diagnosis made by	
	Data management method	
	Dissemination method	

Table 2: 2.1 Characteristics related to the aim of the surveillance activity

Characteristic	Options or examples
Surveillance purpose[r]	Describes the type of information that will be obtained about the occurrence of a health hazard using a particular surveillance activity • **Early detection / warning** of known (exotic or re-emerging) or unknown (new) disease • **Substantiate freedom** from disease or infection • **Describe the baseline level, distribution and impact** of specified disease(s) • **Describe changes in the health** of the population, including changes in health indicators or in the occurrence of specified diseases • **Describe changes that mightthreaten the health** of the population, this may include changes in the population structure or in its exposure to risk factors • **Detect cases** of diseases that are currently present to allow action to be taken to control disease
Policy purpose	Describes how surveillance information is used by policy makers to inform decisions about how best to support policy objectives such as maintaining a healthy and sustainable food and farming industry, protection of the livelihood of producers, other value chain stakeholders and public health and to support national economic development. The specific decisions that surveillance information can assist policy makers with are: • **Management of outbreaks:** whether additional control measures are required to limit the spread of an emerging or exotic disease outbreak • **Informing trade:** whether to permit import or support export of animals or animal products. This decision should be based on evidence about the prevalence and distribution of disease and about the risk of disease transmission through the commodity being traded. The purpose being to protect the indigenous population and facilitate access to international markets • **Prioritisation:** how to prioritise surveillance and control measures for different health hazards. The prioritisation should be based on the level of hazard occurrence and impact on animal health and welfare, public health, trade and the wider economy; the prioritisation should use information about the relative importance of hazards • **Informing control:** whether existing control measures should be maintained, stopped, or changed to improve the efficiency of surveillance and risk mitigation. This may include providing reassurance about the absence of specific existing or new diseases (which could threaten animal health or welfare or public health) to confirm that risk mitigation is not required.
Expected outcome	E.g. Improved health or reduced prevalence of specified diseases
Anticipated actions taken	E.g. Culling of affected animals or herds, vaccination of animals at risk or treatment of products at the abattoir

Notes

[r] We have used the term 'surveillance purpose' to describe the information that will be obtained from a surveillance activity but this could also be called the 'surveillance objective. We have used the word purpose to avoid confusion with the more specific surveillance objectives of individual surveillance activities. In addition there may also be additional benefits which result from surveillance activities but these are not considered to be the primary purpose of the surveillance activity, these include hypothesis generation, identification of risk factors for disease, improved understanding of the epidemiology of a disease e.g. following the emergence of a new disease, facilitating epidemiological and laboratory research.

Table 3: 2.2 Characteristics related to the organisation of the surveillance activity

Characteristic	Options or examples
Scope of surveillance activity	• **Component:**[20] a single surveillance activity (defined by the source of data and the methods used for its collection) used to investigate the occurrence of one or more hazards in a specified population • **System or network:** [7,20, s] a range of surveillance components (and the associated organisational structures) used to investigate the occurrence of a single hazard in a specified population • **Portfolio:** a range of surveillance components (and the associated organisational structures) used to investigate the occurrence of more than one hazard in a specified population
Unit of interest	Units selected for sampling in surveillance activity (level of sampling) E.g. animal, farm, batch, village
Stakeholders – owners and beneficiaries	Name of organisation(s) paying for the surveillance activity and identification of beneficiaries
Management – personnel and organisational structure	Name of organisation(s) and expertise of the personnel managing the surveillance activity and description of the organisational structure
Relationship with mitigation activity[7]	• Integrated • Autonomous
Basis of participation	• Voluntary • Voluntary recruitment with mandatory participation • Mandatory
Year started	Year surveillance activity initiated
Number of units examined per year	Units examined per year
Associated legislation and regulations	A description of any legislation or regulations which act as the basis for determining the requirement for surveillance including whether there are any compensation arrangements and any requirement for ethical approval

Table 4: 2.3 Characteristics related to population included in surveillance activity

Characteristic	Options or examples
Geographical area included	• **Local:** [t] an area within a country (e.g. border post, surroundings of natural park) • **National:** an entire country • **International:** includes a number of countries
Species and breed	Species and breed included (indicate whether this species is being used as a substitute to assess the occurrence of disease in another species i.e. proxy)
Sample size calculation	Basis of sample size used including within and between herd design prevalence and whether prior risk of disease was taken into account (i.e. risk-based requirement)
Whether sampling is risk-based[u] and the basis of the risk-based sampling	Whether the sampling strategy is risk-based and if so whether the population included has been selected because it is more likely to: • be exposed to the agent of interest; • become affected with the disease of interest; • be affected with the disease of interest; • be detected as affected with the disease of interest; • transmit the disease of interest to other units in the population; • result in other consequences (e.g. transmission to other populations (including zoonoses), large economic loss or trade restrictions)
Sampling strategy[u] (for selection of study population from target population)	• Census • Random • Systematic (e.g. selected on certain days) • Convenience • Haphazard • Purposive • Volunteer • Event-related[v] (e.g. pre or post movement) • Participant recommendation
Population stream	• Healthy live • Healthy cull e.g. animal sent to abattoir • Sick live • Sick cull e.g. animal sent for casualty slaughter • Dead i.e. death on farm
Age	E.g. Adult, young stock
Livestock sector	E.g. Herd type, production type

Notes

[t] In some countries (e.g. Switzerland and UK) surveillance activities that are carried out in areas within a country are described as regional and in other countries these are described as provincial but as these terms are not used consistently in different countries they have not been included as options here

[u] Whether to use a risk-based sampling strategy is the first decision in the design of the overall sampling strategy, ideally random sampling would then be used within the selected high-risk population but other sampling strategies could also be used

[v] Event-related sampling as used here describes the selection of the study population based on the occurrence of an event and is different from 'event-based (media-based) surveillance' as defined in the general definitions section which is the use of media sources to identify disease outbreaks

Table 5: 2.4 Characteristics related to the disease of interest

Characteristic	Options or examples
Disease focus	• **Hazard-specific:**[f] – surveillance that is focused on one or more pre-defined hazards; often using diagnostic tests for the detection of particular pathogens (e.g. molecular diagnostic tests) • **General:** surveillance that is not focused on specific hazards and that uses general tests (e.g. clinical examination or gross pathology)
Name(s) of health hazard(s)	Name(s) of health hazard(s) to be investigated
Pattern of disease occurrence	• **Endemic:** The constant presence of a disease in the population of interest • **Sporadic:** A known disease which occurs intermittently in an irregular or haphazard pattern • **Exotic:** A previously defined (known) disease that crosses political boundaries to occur in a country or region in which it is not currently recorded as present • **Re-emerging:**[21, w] A previously defined (known) disease that is currently either absent or present at a low level, in the population in a defined geographical area that re-appears or significantly increases in prevalence • **New** [21, w] (emerging): A previously undefined (unknown) disease or condition, which might result from the evolution or change in an existing pathogen or parasite resulting in a change of strain, host range, vector, or an increase in pathogenicity. This might also be due to the occurrence of any other previously undefined condition.
Disease presence	• Present • Absent • Not known
Disease mitigation stage[22]	• **Sustainment:** to detect (re)-emerging or exotic hazards or document free status in a situation of established absence from the hazard • **Investigation:** to obtain epidemiological indicators and establish an understanding of a hazard that is present • **Implementation:** – to inform an ongoing intervention programme
Whether disease is generally considered to be zoonotic	• Yes • No • Insufficient knowledge

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Notes

[w] The terms 'emerging' and 're-emerging' disease have been used with various meanings. In line with the definition of an 'emerging' disease proposed by King[21] we have included both previously undefined conditions and changes in the nature of an existing pathogen as 'new' diseases to avoid confusion with other definitions of 'emerging' disease. The OIE terrestrial code[2] definition of 'emerging' diseases includes both of the disease types that we have defined as 'new' and the diseases that we have defined as 'exotic'. We have distinguished 'new' and 'exotic' diseases because the surveillance strategies that can be used for existing 'exotic' diseases may be different from the strategies required for 'new' diseases so it is important to make this distinction when designing surveillance activities. We have also distinguished 'exotic' from 're-emerging' diseases both of which are defined as 're-emerging' diseases by King. In addition 'new' or 're-emerging' diseases may be due to the true emergence or re-emergence of a disease or the apparent emergence of these diseases resulting from the use of new technologies and better diagnostic tools, heightened awareness or increased sampling efforts rather than the true emergence due to a large-scale, long term trend of the occurrence of a new disease[23], in which case these diseases would be more correctly classified as 'endemic'.

Table 6: 2.5 Characteristics related to information management

Characteristic	Options or examples
Origin of data[,7, 24]	• **Active[p] (proactive)** – Investigator-initiated collection of animal health related data using a defined protocol to perform actions that are scheduled in advance . Decisions about whether information is collected, and what information should be collected from which animals is made by the investigator. • **Passive[p] (reactive)** – Observer-initiated provision of animal health related data (e.g. voluntary notification of suspect disease) or the use of existing data for surveillance. Decisions about whether information is provided, and what information is provided from which animals is made by the data provider. • **Enhanced passive[p]** – Observer-initiated provision of animal health related data with active investigator involvement e.g. by actively encouraging producers to report certain types of disease or by active follow up of suspect disease reports.
Data collection method	Examples include postal, telephone, visit (face-to-face), Internet, focus group. For some options data collection can also be categorised as manual or electronic.
Sampling methods	Type of sample and whether samples were pooled
Study design	• Case reporting (voluntary or mandatory) • Survey • Continuous collection • Participatory • Sentinel • Event-based (media-based)
Case definition	• Clinical signs or syndrome (including death) • Indirect indicators (e.g. drug sales, production or performance information, abattoir submissions) • Gross pathology • Laboratory test for pathogens or toxins • Laboratory test for host response (e.g. serology) • Specified diagnostic criteria (e.g. diagnostic codes (Veterinary Investigation Diagnosis and Analysis(VIDA)) code used in GB early warning surveillance system) • Risk factor(s)
Data analysis method	A description of the measures used to assess disease occurrence (e.g. incidence, prevalence, case numbers) and how the data are analysed include; the spatial and temporal methods used, the frequency of analysis, whether real-time and whether contextual information (e.g. the risk of introduction and the prior likelihood of disease) will be incorporated
Who is data provided by	E.g. Farmer, vet, laboratory staff, haulier
Location of data collection	E.g. Farm, village, household, abattoir, market, fallen stock collection site, watering point, laboratory, drug sales outlet, vet
Who makes diagnosis	E.g. Farmer, Vet, laboratory staff, abattoir staff
Data management methods	A description of how data is managed e.g. whether a central relational database is used and the methods used to ensure confidentiality and security of information
Dissemination method	A description of the methods used for disseminating surveillance information during and after surveillance including whether web-access is possible and the methods used for data sharing

3. Surveillance evaluation attributes

Table 7 lists the attributes that can be used to evaluate surveillance activities. This list of evaluation attributes is largely based on the work carried out in an ongoing project to develop a generic framework for the evaluation of animal health surveillance systems[25] and a recently developed evaluation framework for animal health surveillance[26]. Many of the definitions of evaluation attributes used in both of these frameworks are based on those used in the existing frameworks for the evaluation of public health surveillance[3,8,27]. All of these frameworks suggest that the evaluation starts with a description of the objectives and design of the surveillance activity to be evaluated before listing the individual attributes to be evaluated. This description could include a description of the extent to which the surveillance design has been based on risk assessments. The individual evaluation attributes which can be assessed are listed below in groups to indicate which aspect of the surveillance system they evaluate. The attributes in the shaded boxes are those that were considered to be most useful for evaluating surveillance activities by those attending the pre-ICAHS workshop in May 2011 or those commenting subsequently. The relationship between these groups of attributes is summarised in Figure 1 and definitions of each attribute are provided in tables 8-15.

Table 7: Attributes that can be used to evaluate surveillance activities (most useful attributes in shaded boxes)

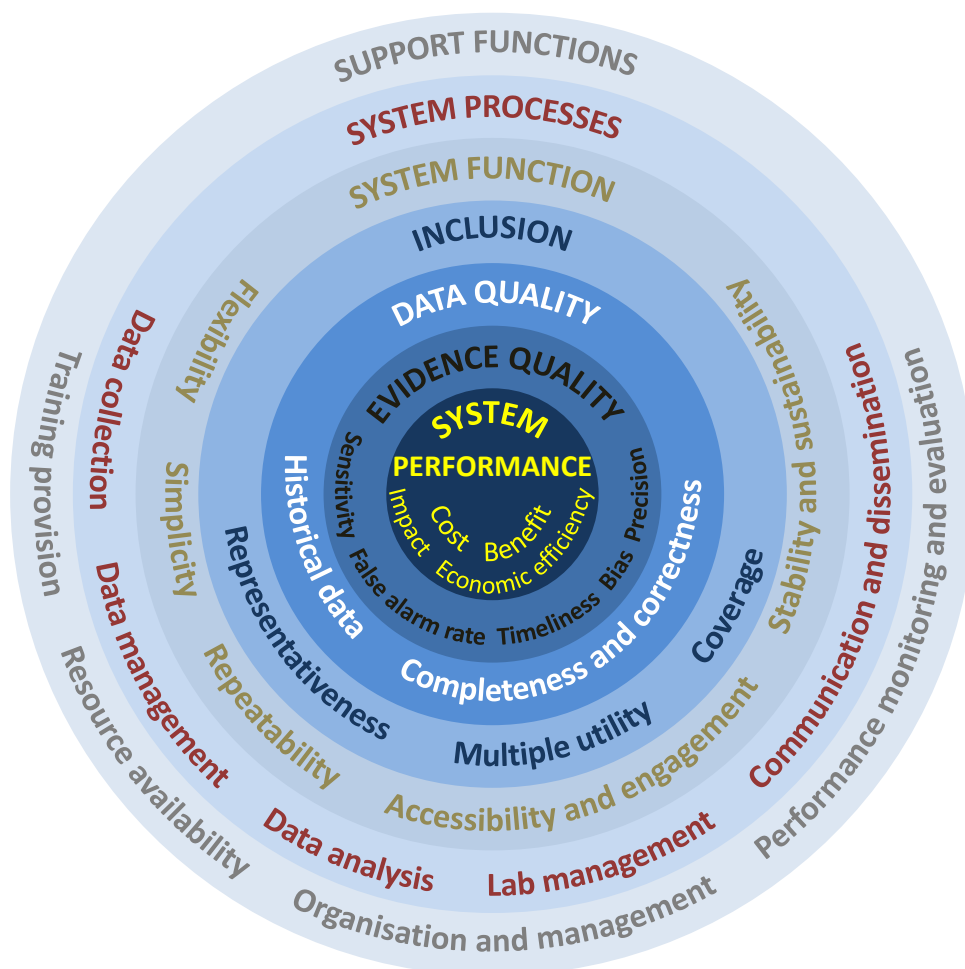| Group	Evaluation attributes within this group
3.1 Support functions	Organisation and management
	Training provision
	Performance monitoring and evaluation
	Resource availability
3.2 System processes	Data collection
	Sampling strategy
	Data storage and management
	Communication and dissemination
	Laboratory management
	Data analysis
3.3 System function	Stability and sustainability
	Acceptability and engagement
	Simplicity
	Flexibility
	Repeatability
3.4 Inclusion	Coverage
	Representativeness
	Multiple utility (inclusion of multiple hazards hazards)
3.5 Data quality	Data Completeness & correctness
	Historical data
3.6 Evidence quality	Sensitivity
	False alarm rate
	Timeliness
	Bias
	Precision
3.7 System performance	Cost
	Impact
	Economic efficiency
	Benefit

Figure 1: Relationship between surveillance evaluation attributes – attributes in each outer circle tend to influence the value of those attributes in inner circles

Table 8: 3.1 Attributes aimed at evaluating the support functions

Attribute	Definition / description
Organisation and management[26]	An assessment of organisational structures include whether the objectives are relevant and clearly defined and the existence of steering and technical committees whose members are representative of the surveillance stakeholders. The members of these committees should have appropriate expertise, clearly defined roles and responsibilities; these member should hold meetings (with minutes taken and kept)regularly to oversee the function of the system.
Training provision[26]	Provision of adequate initial training and an ongoing program of training for those implementing the surveillance system
Performance monitoring and evaluation[26]	Whether performance indicators are routinely used to monitor system performance and periodic external evaluations are used to assess the system outputs in relation to its objectives
Resource availability	An assessment of the financial and human resources available for implementing the surveillance activity including the expertise and capability of personnel

Table 9: 3.2 Attributes aimed at evaluating the system processes

Attribute	Definition / description
Data collection[25]	The use of appropriate data sources and collection methods including automation of data collection where appropriate and the existence of a case definition and a data collection protocol
Sampling strategy	Use of appropriate sampling strategies including the use of risk-based approaches (i.e. risk-based requirement calculation or risk-based sampling) and pooled sampling where appropriate. The basis of the risks used in the design of the risk-based sampling strategy should be assessed.
Data storage and management[25]	Appropriate use and documentation of data management systems for processing information, including data processing protocols, and effective use of data verification procedures and of data storage and back-up procedures
Communication and dissemination[25]	An assessment of the methods used and ease of information exchange between people involved at all levels of the surveillance system (providers, analysers and users of surveillance data). Include an assessment of the data and information provided and of the timeliness and types of outputs produced. The efforts made to disseminate these outputs including the use of web-based systems should also be assessed. The methods used to provide feedback to data providers and to increase their awareness about hazards and surveillance activities should also be assessed. Internal communication and dissemination is directed at those working within the surveillance network or system. External communication and dissemination is directed at those outside the surveillance network or system (e.g. international organisations).
Laboratory management[25]	Whether testing is carried out using appropriate methods with quality assurance scheme and timely and accurate delivery of results
Data analysis[25]	Whether appropriate methods are used for the analysis and interpretation of data at an appropriate frequency

Table 10: 3.3 Attributes aimed at evaluating the system function

Attribute	Definition / description
Stability and sustainability[3,8,25]	The ability to function without failure (reliability), the ability to be operational when needed (availability) and the robustness and ability of the system to be ongoing in the long term (sustainability).
Acceptability and engagement[3,8,25]	Willingness of persons and organisations to participate in the surveillance system, and the degree to which each of these users is involved in the surveillance process including the participation of stakeholders in the steering and technical committees. Could include an assessment of stakeholder awareness of the system and their understanding of it. Could also assess their beliefs about the benefits or adverse consequences of their participation in the system including the provision of compensation for the consequence of disease detection.
Simplicity[1]	Refers to the surveillance system structure, ease of operation and flow of data through the system.
Flexibility[3,8,25]	Ability to adapt to changing information needs or operating conditions with little additional time, personnel or allocated funds. Flexible systems can accommodate new health-hazards, changes in case definitions or technology, and variations in funding or reporting sources
Repeatability[25]	How consistently the study results can be reproduced over time.

Table 11: 3.4 Attributes aimed at evaluating inclusion

Attribute	Definition / description
Coverage[25]	The proportion of the population of interest (target population) that is included in the surveillance activity.
Representativeness[1,3,8,25]	The extent to which the features of the population of interest are reflected by the population included in the surveillance activity. These features may include herd size, production type, age, sex or geographical location or time of sampling (important for some systems e.g. for vector-borne infection)
Multiple utility[25]	Whether the system captures information about more than one hazard

Table 12: 3.5 Attributes aimed at evaluating the quality of the data collected

Attribute	Definition / description
Data completeness and correctness[1,3,8,25]	The proportion of data that were intended to be collected that actually was collected and the proportion of data entries that correctly reflect the true value of the data collected
Historical data[25]	Quality and accessibility of archived data.

Table13: 3.6 Attributes aimed at evaluating the quality of the evidence provided

Attribute	Definition / description
Sensitivity[1,8,25]	Sensitivity of a surveillance system can be considered on three levels. • **Surveillance sensitivity (case detection)** refers to the proportion of individual animals or herds in the population of interest that have the health-related condition of interest and that the surveillance system is able to detect • **Surveillance sensitivity (outbreak detection)** refers to the probability that the surveillance system will detect a significant increase (outbreak) of disease. This requires a clear definition of what constitutes an outbreak. • **Surveillance sensitivity (presence)** –refers to the probability that disease will be detected if present at a certain level (prevalence) in the population.
False alarm rate	Proportion of negative events (e.g. non-outbreak periods) incorrectly classified as events (e.g.outbreaks). This is the inverse of the specificity[25] but can be more easily understood than specificity.
Timeliness[3,8,25]	Timeliness can be defined in various ways • This is usually defined as the time between any two defined steps in a surveillance system. , The time points chosen are likely to vary depending on the purpose of the surveillance activity. For outbreak detection this can be defined using various time points (e.g. the time between exposure to the infectious agent and the initiation of risk-mitigation measures or the time between when disease could have been detected and reported and the time when it actually was reported). • For planning purposes timeliness can also be defined as whether surveillance detects changes in time for risk-mitigation actions to reduce the likelihood of further spread. One way of measuring this would be to assess the number of cases present in the population when disease was detected. The precise definition of timeliness chosen should be stated as part of the evaluation process.
Bias[25]	The extent to which a prevalence estimate produced by the surveillance system deviates from the value of the true prevalence . Bias is reduced as representativeness is increased
Precision[25]	How closely defined a numerical estimate is. A precise estimate has a narrow confidence interval. Precision is influenced by prevalence, sample size and surveillance system quality.

Table 14: 3.7 Attributes aimed at evaluating the performance of the system

Attribute	Definition / description
Cost[3,25]	The evaluation should list and quantify each of the resources required to operate the surveillance system and identify who provides eachresource. These resources could include: time, personnel, financial input and equipment.
Impact[25]	This indicates the changes that have been made based on the results of the surveillance providing a measur of the usefulness of the surveillance system in relation to its aims. This should include details of actions taken as a result of the information provided by the surveillance system (e.g. changes in protocols or behaviour, changes in mitigation actions and especially changes in disease occurrence
Economic efficiency[1,28, x]	Whether the surveillance system produces the desired effect without wasting resources. Three levels of economic efficiency can be defined: • Optimisation: maximising the net benefit to society achieved by the allocation of scarce resources to animal health surveillance and intervention to avoid losses resulting from animal diseases • Acceptability: ensuring that the benefits generated by a mitigation policy at least cover its costs, this is commonly assessed using cost-benefit analysis • Cost-minimisation: ensuring that a technical target for disease mitigation (e.g. time to detection) is achieved at minimum cost without quantifying the benefit in monetary terms, this can be assessed using cost-effectiveness or least-cost analysis
Benefit[25]	Direct and indirect advantages produced by the surveillance system. This does not need to be limited to financial savings and better use of resources but can also include any losses avoided due to the existence of the system and the information it provides. These avoided losses may include improved animal production; maintenance of a structured network of actors able to react appropriately against a future threat; improved public health; increased understanding about a disease; maintained or increased trade; or improved ability to react in case of an outbreak of disease

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Appendix 1 – Participants at the pre-ICAHS workshop held in May 2011

Workshop participants (n=29) – those in bold provided comments on the draft outputs or participated in discussions about specific definitions following the workshop

Name	Organisation	Country
Lis Alban[*]	Danish Agriculture & Food Council	Denmark
Didier Calavas	**Anses**	**France**
Julian Drewe[*]	**RVC**	**UK**
Celine Dupuy	Anses	France
Alexandre Fediaevsky	Ministry of Agriculture	France
Toby Floyd[*]	AHVLA	UK
Jane Gibbens	**AHVLA, Defra**	**UK**
Flavie Goutard	CIRAD	France
George Gunn	SAC	UK
Lori Gustafson	**USDA**	**USA**
Barbara Häsler	**RVC**	**UK**
Linda Hoinville[*]	**AHVLA**	**UK**
Ann Lindberg	**National Veterinary Institute**	**Sweden**
Jeffrey Mariner	**ILRI (OIE Epidemiology ad hoc group member)**	**Kenya**
Ailsa Milnes	AHVLA	UK
Sophie Molia	**CIRAD**	**Mali**
Jean-Baptiste Perrin	Anses	France
Giuseppe Ru	Instituto Zooprofilattico Sperimentale	Italy
Claude Saegerman	University of Liege	Belgium
Mo Salman[*]	**Colorado State University**	**USA**
Sara Schaerrer	University of Bern	Switzerland
Heinzpeter Schwermer	Federal Veterinary Office	Switzerland
Aaron Scott	USDA	USA
Katharina Stärk[*]	**RVC**	**UK**
Daan Vink	Massey University	New Zealand
Linda Van Wuyckhuise	GD Animal Health Services, Deventer	Netherlands
Eamon Watson[*]	AHVLA	UK
Preben Willeberg	**University of California**	**USA**
Jennifer Wood Roe	AHVLA, Defra	UK

* These participants contributed to the organisation and conduct of the workshop as group facilitators or note-takers

Appendix 2 – Others included in the circulation of the draft workshop outputs

Others who were not able to attend the workshop but who were provided with an opportunity to comment on the draft output (n=20) – those in bold provided comments on the draft outputs or participated in discussions about specific definitions following the workshop

Name	Organisation	Country
Carolyn Beningo	FAO	Thailand
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Alex Cook	AHVLA	UK
Marcus Doherr	University of Bern	Switzerland
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Barbara Dufour	Alfort Veterinary School	France
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Lea Knopf	OIE	France
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Dirk Pfeiffer	**RVC**	**UK**
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Appendix 3 – Final report reviewers

Final report reviewers who checked the final definitions and identified any discrepancies between the terminology proposed in this document and those currently used in their country or field of expertise (n=26 individuals or groups)

Name	Country / region / area of expertise
Ronello Abila	South East Asia
Lis Alban	Denmark
David Buckeridge	Public health, USA
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Angus Cameron	Australia
Dickens Chibeu	AU-IBAR, Kenya
Marcus Doherr	Switzerland
Alex Elliot and Gillian Smith	Public health, syndromic surveillance, UK
Jane Gibbens	Policy, UK
Vitor Gonçalves	Brazil
Lori Gustafson, Aaron Scott,Marta Remmenga and Celia Antognoli	USA
Kathian Herbert Hackshaw, Victor Gongora andJennifer Pradel	CaribVET, Caribbean
Daniela Hadorn	Switzerland
Barbara Häsler	Animal health economics, UK
Ann Lindberg	Sweden
Vincent Martin, Ning Haiqiang, Xueguang Zheng and Guo Fusheng	China
Sophie Molia, Flavie Goutard and Francois Roger	Developing countries
Dirk Pfeiffer	UK
Claude Saegerman	Belgium
Mo Salman	USA
Katharina Stärk	UK
Gerdien Van Shaik	Netherlands
Daan Vink	New Zealand
Howard Wong	Hong Kong
Him-Hoo Yap	Singapore
Cristobal Zepeda and Jeffrey Mariner	OIE, developing countries

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