Surveillance principles and methods

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Definition of surveillance

An ongoing, systematic process of collection, analysis and interpretation of animal health-related data aimed at early detection of a specific disease or agent in a population or early prediction of elevated risk of a population acquiring an infectious disease, with a pre-specified action that would follow the detection of disease.

Surveillance basically means keeping watchful eye on the animal health status in a country or region

Definition of surveillance

It is important to distinguish surveys from monitoring from surveillance

Surveys are usually directed to identify a specific problem (for instance a preliminary survey carried out to have an estimate of prevalence before implementing a surveillance system for a specific disease) and surveys are usually limited in time. Surveys may be one component of a surveillance system as a whole

Monitoring may share common features with surveillance programs with the main difference being that monitoring activities do not require a pre-specified action to be taken

Objectives of surveillance

Possible objectives of a surveillance system may include the following:

- To detect clinical disease and infection
- To understand the epidemiology and ecology of a given disease, as well as its socioeconomic impact, to help to design effective control programs
- To monitor for antigenic changes of the agent
- To demonstrate freedom from clinical disease and absence of infection in a country or compartment and thereby facilitate trade
- To assess the efficacy of vaccination (where used)

Types of surveillance

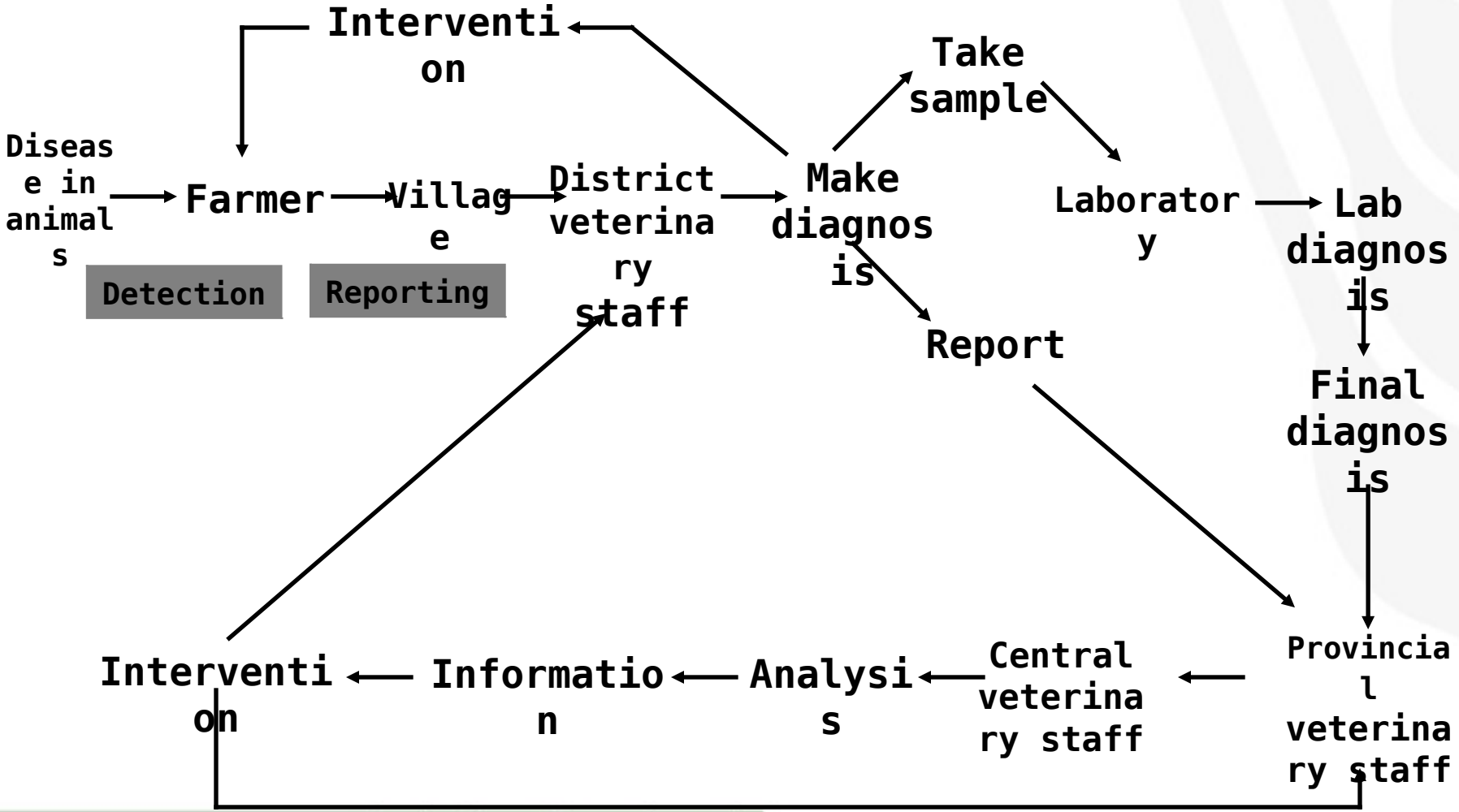
- Passive:
  - The system whereby veterinary authorities make no active efforts to collect disease information; wait for the disease reports to come to them.
  - The livestock owner initiates the report and veterinary service waits for the report to arrive
  - The most common form of information collection
    - Routine monthly field reports
    - Abattoir/market reports
    - Laboratory reports
- Active:
  - The users of the information make active efforts to collect the information needed:
    - Regular programmed inspections (stock inspections, border posts)
    - Randomized survey including sero-surveillance
    - Participatory techniques

Types of surveillance

- Both passive and active component may be present within a framework of a surveillance system and contribute to the overall ability of the system to achieve the objectives;

- The terms are used to describe two alternatives approach to surveillance. They are conceptually useful but may not be feasible for describing a surveillance method

Typical surveillance chain components



Cycle of surveillance

- Surveillance systems can be also described as information loops, with data coming into the collecting organization that will be responsible for collating, analyze and disseminate information to those who need it;

- In the previous graph it could be seen that the loop initiate with an health event which is detected by the system

Surveillance and disease control

It is important also to distinguish these two concepts as they mean different things:

- Surveillance involves data collection, processing and analysis. The production of this information is in support of disease control activities;

- Disease control activities make use of prophylactic (vaccination) or sanitary measures (quarantine, slaughter, movement control, ect..) and in order to be most effective require that a good understanding of the status of the population is known (through surveillance)

Designing a surveillance system

- Some preliminary considerations are essential when attempting to design a surveillance system:
  - the Health phenomena must be relevant (in terms of morbidity, mortality, economic losses, access to trade, etc..)
  - Must be useful in that it produces information that can be used in disease control activities

Designing a surveillance system

- Introduction
- Establish objectives
- Case definition
- Target areas
- Target population
- Sample size
- Activities (Collection of data and data management)
- Response plan
- Identification of stakeholders and responsible parties
- Estimating costs
- Evaluation

Designing a surveillance system (Introduction)

- Introduction should describe the rational for establishing the surveillance system and provide a description of the disease (or syndrome) targeted by the system
- It is important at this stage to describe if the disease is already present in the country or the rational for implementing surveillance activities is to detect early introduction

Designing a surveillance system (Objectives)

- Early detection
  - foreign animal diseases (FAD)
    - Rapid detection of FAD
    - Monitor risk
  - emerging diseases
    - describe trends in hazards, exposure
    - recognition of emerging disease
- Surveillance for diseases control purposes
  - progress in eradication campaign
  - progress in education campaign
  - reduction of food-borne pathogens
- Surveillance for trade purposes
  - document disease free status
  - describe disease prevalence patterns for regionalization/compartimentalization

Designing a surveillance system (Objectives)

- Surveillance system's objectives must be precisely defined as those will determine the way in which the surveillance system is going to operate

- The surveillance system may have different sub-objectives, in this case it may be advisable to state the main purpose and then define the sub-objectives

Designing a surveillance system (Objectives)

- Example: detect occurrence of Highly and Low Pathogenic Avian Influenza in domestic poultry and wild birds.

- This could be the main purpose of the surveillance system with different sub-objectives such as:
  - Detection of HPAI in domestic poultry
  - Detection of HPAI and LPAI in wild bird
  - Detection of LPAI in domestic poultry

Each of those may be a sub-component of the surveillance system

Designing a surveillance system (Objectives)

- The objectives of the surveillance system must be agreed by those involved in the implementation of the system Example: detect occurrence of Highly and Low Pathogenic Avian Influenza in domestic poultry and wild birds.

- This could be the main purpose of a surveillance system with different sub-objectives such as:
  - Detection of HPAI in domestic poultry
  - Detection of HPAI and LPAI in wild bird
  - Detection of LPAI of H5, H7 and H9 subtypes in domestic poultry

Designing a surveillance system (Case definition)

- Defining a case is a fundamental step in the development of a surveillance system and requires an assessment of the objectives, logistic and resources available;
- For some diseases, definition of a case may be stratified according to the level of confirmation (i.e. possible case, confirmed case);
- The case definition adopted affect the overall sensitivity of the system

Designing a surveillance system (Case definition)

- If the case definition is very broad (high sensitivity), and it requires laboratory confirmation, the workload for the laboratories could be very high and this should be considered in terms of human and financial resources;
- If in the system there are different sub-objectives is likely that different case definition may be developed.

Designing a surveillance system (Case definition)

- For Avian Influenza FAO has developed recommended 'trigger points' and these are the criteria that would trigger a disease investigation by official veterinary services. These criteria essentially describe 'unusual circumstances', in terms of 'normal' poultry production in the four production sectors described subsequently. Official veterinary services, in consultation with industry and poultry production specialists, should confirm the values that are valid for their countries/production sectors and apply them. This validation could be done by means of consultation or small surveys. A similar process should be employed to identify norms and trigger points for other poultry species.

Designing a surveillance system (Case definition)

Sector Trigger point for chickens

- Production Sector 1: Food and water intake reduced by 20% for one day; or mortality of 1% for 2 days
- Production Sector 2: Daily mortality of 1% for 2 days
- Production Sector 3: Daily mortality of 1% for 2 days
- Production Sector 4: Daily mortality of 5% for 2 days

Designing a surveillance system (Target area)

- For each component of the surveillance system the geographical area targeted for the activities of the surveillance system should be described. For some components may be the entire country while for others may be some particular territory with specific characteristics (i.e. wetlands)

Designing a surveillance system (Target population)

- For each component of the surveillance system the target population will need to be described.
- If, for example, the system is designed for Avian Influenza in domestic poultry reference can be made to the categorization used in FAO in different productive sectors (from 1 to 4)
- For wild birds a description of the target species should also be provided according to the data available in the literature on the role that different species may have in the ecology of Avian Influenza viruses

Designing a surveillance system (Target population)

- Sector 1: Industrial integrated system with high level biosecurity and birds/products marketed commercially
- Sector 2: Commercial poultry production system with moderate to high biosecurity and birds/products
- Sector 3: Commercial poultry production system with low to minimal biosecurity and birds/products entering live bird markets (e.g. a caged layer farm with birds in open sheds; a farm with poultry spending time outside the shed; a farm producing chickens and waterfowl).
- Sector 4: Village or backyard production with minimal biosecurity and birds/products consumed locally.

Designing a surveillance system (Sample size)

- It is likely that some activities foreseen in the surveillance system will be carried out on a statistical sample of the population. The units of concern should be clearly described and the number of biological samples to be collected must be provided.
- For example in the decision of EU 2007/268/EC (that provides guidelines for the implementation of surveillance programs within Member States for Avian Influenza) it is stated that “number of poultry holdings to be sampled should ensure the identification of at least one infected holding if the prevalence of infected holdings is at least 5% with a 95% confidence level. In addition the number of birds to be sampled in each holding should ensure 95% probability of identifying at least one positive bird if the prevalence is equal or more 30%.

Designing a surveillance system (Sample size)

- The unit of concern may also vary according to the target population. For instance for backyard poultry sector the first unit of concern can be an entire village, while the second stage of the sample can be individual birds presents within single households

Designing a surveillance system (Collection of data)

- The type of data to be collected should be standardized and appropriate forms developed for each component of the system (independently from the approach followed may this be active or passive).

- Different sources can provide data to the system. Some of those can be generated because of an active approach while others may be generated through the passive component of the system

Designing a surveillance system (Collection of data)

- Note that certain infectious diseases are notifiable and their occurrence must be reported, nevertheless field veterinarians may be able to report only those health events that match the case definition and for which a confirmatory diagnosis is required

Designing a surveillance system (Collection of data)

The issue of reporting is essential because it involves also farmers. The system (theoretically) must ensure that:

- The owners know
  - what to report (case definitions and trigger points)
  - who to report to (village headman, vet technician, local vet, govt vet, hotline)
  - how to report (contact details)
- The vet technicians/private vets know
  - How to respond to a report
  - What requires onward reporting and how to do that
- The local govt vets
  - Know how to respond to a suspect report
  - Can and will respond consistently and quickly

Designing a surveillance system (Data management)

- This activity will describe to whom the data collected should be forwarded and how the data are going to be analyzed. It is common that a central unit store and processes the data and once processed those will generate information (outputs of the system) that can then be utilized and disseminated. Dissemination of the information generated is rather important process as represent a feedback for those involved in the surveillance activities.

Designing a surveillance system (Data management)

- It is important to describe which will be the outputs of the system along with the periodicity for the production of those outputs;
- The outputs of a surveillance system will usually provide a description of the disease under surveillance in terms of time, place animals

Designing a surveillance system (Example of an output)

Designing a surveillance system (Identification of stakeholders)

- Relevant stakeholders need to be identified. Those can be decision makers, representatives of the farmers, etc..
- It is essential that there is an agreement on how the system will operate;

Designing a surveillance system (Responsible parties)

- A relevant number of persons (with different backgrounds) may be involved in the implementation of a surveillance system (field veterinarians, laboratory workers, district veterinarians, farmers, information technology experts, etc..). It is crucial that in designing the system those responsible parties are either directly involved or kept informed as to avoid bottle necks that may easily occur.

Designing a surveillance system (Responsible parties)

- Organizing training for those responsible parties involved in the system implementation is essential. Those training activities besides being directed to improve the ability of field staff in recognizing the health events of concern of the system, should also provide essential information on the general operation of the system so that each actor knows how the system works and what are the purposes.

Designing a surveillance system (Response plan)

- Ensure that a response plan is developed and actions to be taken are identified
  - Questions
    - What control strategies can be implemented ?
    - How will efficacy of intervention strategies be assessed ?
    - What policies/regulations should be put in place (if any) ?

Designing a surveillance system (Estimating costs)

- Once the design of the technical part of the surveillance system is designed it is necessary to turn into financial aspects. This obviously related to the human resources necessary to run the system (how many teams are necessary for field work ? For how many days per month ? Etc..) and to the equipment (laboratory equipment and supplies, reagents, field equipment, etc..)

Evaluation of a surveillance system

(from Modern Epidemiology; Rothmann K.J.; Greenland S.; Lippincot Ed.)

- Surveillance systems can be evaluated using a list of attributes. It may be necessary to establish which of those may be more relevant for evaluating the specific system.
- The attributes can be listed as follows:
  - *Sensitivity:* To what extent does the system identify all of the events in the target population ?
  - *Timeliness:* This attributes refers to the entire cycle of information flow, ranging from collection to dissemination. The need for timeliness depends on the urgency of a problem and types of intervention available

Evaluation of a surveillance system

- *Representativeness:* To what extent do events detected through the surveillance system represent animals with the condition of interest in the target population ? A lack of representativeness may lead to misallocation of resources
- *Predictive value:* To what extent are reported cases (outbreaks) which are true cases/outbreaks ?
- *Accuracy and completeness of descriptive information:* Forms for reporting health events often include auxiliary data such as names, location or potential exposures. To what extent are those sections of forms completed ?
- *Simplicity:* Are forms easy to complete ? Are procedures unobtrusive ?
  Is data collection kept to a necessary minimum ?

Evaluation of a surveillance system

- *Flexibility:* Can the system change to address new questions ? Can it adapt to evolving standards of diagnosis or therapeutic care ?
- *Acceptability:* To what extent are the participants in a surveillance system (responsible parties) happy about the system ?

Conclusion

Thorough planning of surveillance efforts is critical

- "Surveillance is not conducted for the sole purpose of collecting data but the express purpose of disseminating health information on a timely basis to decision makers"

Conclusion (from Modern Epidemiology; Rothmann K.J.; Greenland S.; Lippincot Ed.)

The power of surveillance as an epidemiologic and public health tool is most dramatically exemplified by the global effort to eradicate smallpox.

The initial WHO strategy for smallpox elimination was based on the principle of mass vaccination.

While this approach retarded smallpox transmission, it provided to be ineffective in interrupting transmission despite high levels of vaccine coverage.

Recognition of the cost of achieving sufficient levels of immunity with the mass vaccination approach led to the development of a new strategy:

Conclusion

(from Modern Epidemiology; Rothmann K.J.; Greenland S.; Lippincot Ed.)

Progressively intensive surveillance efforts identified where and when outbreaks were occurring and who was at risk of exposure. Data from these reports were rapidly collated and used to direct vaccination teams. Thus, rapid vaccination of several hundreds persons in the vicinity of a case was sufficient to interrupt transmission rapidly. This approach was successfully applied in different countries and led directly to the global eradication of this disease (Henderson, 1972)