
Animal Disease Surveillance: A Framework for Supporting Disease Detection in Public Health

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Background

Animal disease surveillance can serve as sentinels for bioterrorist or natural infectious disease epidemics. As such, it is important to understand how animal disease affects humans and how this information can be obtained and monitored on a regular and timely basis.

Many animal and public health professionals are eager to improve surveillance for animal diseases (AD). In the aftermath of European outbreaks of Foot and Mouth Disease and bovine spongiform encephalopathy (BSE) and because of concerns about biosecurity, many states have reviewed their surveillance, diagnosis, and containment policies for animal disease reporting. There has been a small amount of federal funding directed specifically at AD surveillance. However, AD surveillance faces many of the problems encountered by surveillance efforts for human disease to include:

- (1) Lack of clear case definitions,
- (2) Fragmented and paper-based information systems, and
- (3) Conflicting governance and regulatory authorities.

Why is animal disease surveillance important

There are two specific reasons that animal disease surveillance is critical. The first, being the direct impact to the human and the second, being an economic impact. Animals as a source of infectious diseases in humans are referred to as zoonoses. Classic examples of this include anthrax and rabies. It also includes spreading of disease through reservoirs via an arthropod vector, such as a mosquito and yellow fever.

Food derived from animals' affects both human and other animals. Human examples include salmonella and campylobacter, while an animal example is BSE. In addition to direct relationships, the antibiotics fed to animals may cause antibiotic resistance in microbes, which also causes disease in humans, thereby,

decreasing the efficacy of those antibiotics in both populations.

There is a second reason is economic. The US "livestock industry" generates \$100 billion annually. Serious economic impacts would be expected if animal disease were introduced, prevalent or suspected. Since animals may be the primary targets of an introduced disease/epidemic it is critical that this population be regularly monitored with all critical diseases reported.

Due to an aggressive disease eradication program, the US is unusually free from infectious diseases affecting animals. As such, there has not been a major effort or a concern sharing information with public health officials monitoring human diseases. With the potential of a bioterrorism event this now becomes more important and sharing of information is essential. In order to develop a surveillance system that integrates the animal disease reporting process with early warning surveillance systems for public health, it is first necessary to understand the at risk population.

Animal populations at risk

There are four categories of animal populations at risk. The categories are especially relevant since they generate surveillance data in different ways. These categories are as follows:

- (1) "Companion" animals (i.e., pets)
- (2) "Animal Industry" (Agricultural)
 - Equine
 - Bovine/ovine
 - Poultry
 - Swine
 - Aquaculture
 - Exotics
- (3) Wild (feral)
- (4) Zoo animals

In each case the likelihood of detecting an animal disease is directly related to the

individuals and professionals that interact with these populations. This includes individuals, veterinarians both small animal and large, farmers, state agencies such as fish and game, agriculture, and public health.

Governing agencies

Animal disease surveillance is state-based. There is no single federal agency responsible for overall governance. The National Association of State Departments of Agriculture Research Foundation's October 2001 report on animal health and disease surveillance stated, "it is not clear 'who is in charge.'" What is clear is that public health is not.

The most prominent federal oversight agencies are the USDA Animal Plant Health Inspection Services-Veterinary Services (APHIS-VS) and the Centers of Epidemiology and Animal Health (CEAH), a quasi-CDC program for animal diseases. The CEAH's main purpose is "to promote research in veterinary epidemiology and animal disease surveillance systems." It is based in Ft Collins, Colorado, and contains four "Centers:" the Center for Animal Diseases and Information Analysis, the Center for Animal Health Monitoring (CAHM), the Center for Emerging Issues (CEI), and the National Animal Health Monitoring System (NAHMS). CDC does not do animal disease surveillance with the exception of human cases of zoonoses.

There are a number of other US government entities with AD surveillance expertise.

Animal disease classification systems and case definitions

There are several classification systems for animal diseases. The one system used most commonly in agricultural public health surveillance is that defined by the *Office International des Epizooties* (OIE), see Appendix 1. OIE categorizes diseases into three lists A, B, and C, based on contagiousness and pathogenicity.

In the United States, a second method to classify ADs is the designation "foreign animal diseases" (FADs). These are diseases which have been eradicated in the US but which persist abroad. These are listed in Appendix 2. These systems emphasize diseases which, if introduced, would be devastating to animals, such as foot

and mouth disease, classic swine fever (a.k.a. hog cholera), or avian influenza.

For reporting standards there are no veterinary diagnostic codes, comparable to the ICD-9 and 10 codes for human disease. The Standardized Nomenclature for Veterinary Diseases and Operations (SNVDO) has an associated numeric code, but is not widely used clinically. OIE and the National Animal Health Reporting System (NAHRS) use a numeric code for reporting diseases, but it is not used universally.

Although there are very detailed guides to the diagnosis of ADs (including "field" or clinical criteria and laboratory criteria) in OIE documents such as the *International Animal Health Code*, there are virtually no case definitions, in a public health or Epidemiological sense. Most of the diagnoses depend on a positive laboratory test, performed according to the OIE's *Manual of Standards for Diagnostic Tests and Vaccines*.

Reportable animal diseases

Much like reportable human diseases, the reporting of animal diseases is legislated independently by each state (relevant state code is available on line in every case). Efforts are being made to standardize state communicable disease control, and the Model State Emergency Health Powers Act addresses "animal diseases" in Section 301, paragraph d.

All states require the reporting of OIE List A diseases at the time of diagnosis. Reporting requirements for approximately 90 additional diseases vary on a state-by-state basis. In some states, there are animal diseases which are not "reportable" but are "monitored," these are usually OIE List B diseases. There are no federal reporting requirements.

Sources of data

One of the primary sources of surveillance data is from individuals. Occasionally they serve as the initial data collection source through notification or in turning in dead animals, for example, crows through the West Nile surveillance process.

Most states have laws which require agriculturalists (e.g., farmers, ranchers) to report confirmed cases of reportable diseases, and urges them to report suspected disease. Animal and

human health professionals and laboratories are required by state laws to report cases of reportable diseases and, in some states, unusual disease occurrences.

While there are hundreds of small, local diagnostic labs serving mainly “small animal” or “companion animal” veterinarians, there are only 32 accredited full-service reference veterinary diagnostic labs in the US and Canada. Some are private (e.g., CliniLab, VitaTech.), some are based at academic veterinary centers (often joint ventures with the state, such as North Dakota State University and Michigan State University) or are state-run (e.g., Texas, Nebraska, Missouri, Florida, North Carolina). State-run veterinary labs usually provide services relevant to that state’s animal industries and are usually administered by the state Department of Agriculture (DOA).

State public health labs may also offer some veterinary diagnostic tests, especially for zoonoses. There are two federal National Veterinary Services Laboratories, one at Ames, Iowa, and one at Plum Island Animal Disease Center in New York.

Electronic information: Infrastructure, vocabulary and standards

Much of the work on health information standards in veterinary medicine has been done by Jim Case, an UC-Davis veterinarian, (jcase@cvdls.ucdavis.edu)

Veterinary-specific requirements have been incorporated into HL7, as animal health professionals have participated in the HL7 working groups. Veterinary information system developers are urged to use HL7 protocols. Similarly, veterinary input has been incorporated into LOINC since 1996. Hundreds of veterinary specific-terms have been included, but not all of the laboratory procedures used in the definition of *OIE* List A and B have been incorporated. Veterinary labs are not required to validate their lab test lists against LOINC standards, but it has been encouraged.

SNOMED now officially stands for the Systematized Nomenclature of Human and Veterinary Medicine. Veterinary-specific terms were first submitted in 1991, and since then, hundreds have been incorporated. The California Veterinary Diagnostic Laboratory System has reviewed its internal nomenclature for coverage

by SNOMED terms, and found that approximately 84% of their terms mapped. The SNDVO, which has been developed over the last 20 years, maps 80% of its terms to the latest version of SNOMED.

Thus, there has been animal disease input, albeit incomplete, into vocabulary and standards. The main obstacle, according to Dr. Case, is a lack of knowledge and interest on the part of animal health professionals.

Note: The NEDSS base documents do not explicitly refer to animal diseases or animal surveillance, nor do any of the APHIS-VS documents suggest that it is a model, which could be borrowed for AD surveillance. There were no web-based discussions of an AD surveillance electronic architecture.

Current software systems in animal disease information management

Animal health information systems parallel human health information systems. There are approximately a dozen veterinary lab information and practice management systems (including VADDS, VetCare, VETECH, VetSoft). The most comprehensive listing of commercial veterinary information systems can be found at <http://netvet.wustl.edu/info.htm>, but many of the links are outdated.

Market share for individual programs is difficult to assess. Many of the larger referral or veterinary school-based labs have developed their own LISs. Clearly, small and freestanding veterinary labs are less likely to have electronic databases than human medical labs. In 1997, a survey by the USDA/APHIS-VS found that about 50% of diagnostic poultry labs had computerized records.

The Emergency Management Response System (EMRS), a computerized system to be used to manage animal disease outbreaks or emergencies, is being developed by the APHIS-VS. It uses Lotus Notes document management and an Oracle DBMS. It includes links to GIS applications. There are four modules:

- 1) Reference material
- 2) Personnel, equipment and costs,
- 3) General tasks, and
- 4) An investigation module, which manages information for tracing, surveillance, and vaccination.

For non-Lotus Notes users, there is a web-browser interface. The databases will have access control.

The WHO distributes an animal disease Epi share-ware program, called EPIZOO, (<http://www.who.int/emc/diseases/zoo/epizoo.html>), with basic statistical and sampling assistance, program evaluation, GIS tools, and outbreak investigation templates. It is MS-DOS based.

There are a number of additional animal health information system tools in use or in development, similar to those used for human health, including decision support tools, practice management (for billing, reminders, and inventory control), prescription management, GIS mapping systems, a Veterinary Medical Record Initiative (UVIS) at the University of Georgia, VMACS at UC-Davis, and the Veterinary Medical Data Base (VMDB) at Purdue.

Animal disease surveillance systems

Current surveillance systems are piecemeal, passive, and disease specific, primarily directed at supporting disease eradication programs for diseases like brucellosis, tuberculosis, and pseudorabies. They are neither designed to nor incidentally able to detect emerging diseases, or natural or introduced outbreaks outside of targeted diseases.

All states require OIE List A diseases to be reported when diagnosed. Other case reports must be turned in annually. Most states require that animal health professionals (including laboratories) and agriculturalists report to the local or regional Department of Agriculture office. The information is channeled to the State Veterinarian or Animal Health Officer. That person decides if further verification or evaluation is warranted. Virtually all of this reporting is paper and telephone-based.

When a reportable zoonosis (e.g., *B. anthracis*, *Yersinia pestis*, *Francisella tularensis*, rabies) is diagnosed in a human, the human health professional is required to report the case to the local health department, which channels the information to the state health department, where it is reviewed by the state Public Health Veterinarian, usually not the same person as the State Veterinarian. State health department may

conduct active animal surveillance, usually serosurveys, for some diseases such as rabies, Lyme disease, and hantavirus.

There are no federal reporting requirements, but state data is compiled by the CEAH in the National Animal Health Reporting System (NAHRS), a joint project of the US Animal Health Association, the American Association of Veterinary Laboratory Diagnosticians and APHIS. NAHRS collects data on commercial animal populations only. Participation is voluntary. Individual state OIE List A and B reports are submitted to the CEAH monthly. Reports do not identify individual producers or locations. NAHRS data is sent to the OIE once a year.

NAHRS is a passive system, without quality control, verification, or feedback. In 2001, only 20 states and territories participated. Animal industry has objected to participating, fearing disclosure of sensitive competitive information.

Numerous veterinary and animal disease agencies have called for an integrated National Surveillance System, based on existing APHIS surveillance, making better use of partnerships with commercial, industry, and veterinary professionals through the use of information technology.

International perspective

Office International des Epizooties

The Office International des Epizooties (based in France) is an independent intergovernmental world organization to protect animal health. It currently has 158 member countries. The OIE collects, analyzes, and disseminates information on animal disease control in an effort to guarantee the sanitary safety of international trade in animals and animal products. The OIE sets international standards, but does not have the power of legal enforcement.

The World Trade Organization

The WTO has a series of AOAs (Agreements on Agriculture) and "Agreements on Sanitary and Phytosanitary (SPS) Measures" which apply to certifying animals and animal products for international trade.

Professional education

There have been aggressive efforts to educate animal health professionals, and to a lesser extent, agriculturalists, about their role in identifying natural or intentional animal disease outbreaks. There is a special educational program in FAD detection for “FAD diagnosticians” (FADDs) at Plum Island.

Strategies for state-based animal disease surveillance

Improving existing AD surveillance efforts requires similar efforts to that dedicated to improving human disease surveillance efforts, only more difficult. The following tasks are recommended.

1. Identify key stakeholders and organizations, to include:
 - ✓ State Vet or animal health officer in DOA (will most likely be lead person in surveillance effort)
 - ✓ Veterinary public health officer in the state health department
 - ✓ State VMA
 - ✓ Veterinary schools
 - ✓ Veterinary diagnostic labs
 - ✓ Prominent stakeholders: animal industry reps
2. Identify relevant animal diseases for the state to include:
 - ✓ Reportable ADs
 - ✓ State animal industry ADs
 - ✓ Wildlife ADs (e.g., rabies, Chronic Wasting Disease)
 - ✓ FADs and potential BT weapons
 - ✓ Zoonoses
3. Based upon the diseases to be reported evaluate the need to revise state codes as necessary.
4. Establish case definitions, including “confirmed” and “suspected,” and standardized report forms for diseases to be included in the surveillance system.
5. Identify existing animal disease surveillance efforts in the
 - ✓ Department of Agriculture
 - ✓ Health department
 - i. For ADs
 - ii. For zoonoses

6. Identify communication channels between DOA (and state vet) and public health.
7. Identify key laboratories and develop communication channels
 - ✓ State veterinary lab
 - ✓ Veterinary school and/or state university-based labs
 - ✓ State public health lab
 - ✓ Private labs
 - ✓ Reference labs
 - ✓ Low volume small labs
8. Develop communication channels between public health officers and data sources especially agriculturalists and animal health professionals.
 - ✓ Work with state veterinary medical association to, educate animal health professionals, encourage participation, and streamline case report submission.
 - ✓ Work with farm bureaus, animal industry associations to, educate agriculturalists, identify obstacles to participation in NAHRS, encourage participation, ensure confidentiality, streamline case report submission
 - ✓ Develop opportunities for feedback to participants.

Framework for a Surveillance System

The information to collect will vary and as such a surveillance system should be customizable to a state. However, in general public health will require the following information to be gathered for unusual animal deaths.

- ✓ Date animal is found
- ✓ Individual taken information
- ✓ Phone, Address, other Contact information
- ✓ What type of animal (species)
- ✓ How many animals
- ✓ Age (infant, adult, geriatric)
- ✓ Location of animal(s)
- ✓ Over how large of an area were they found
- ✓ Signs of traumatic injury
- ✓ Do the animals appear normal, skinny, eating well, ...
- ✓ Were they seen before death, if so how were they acting

- ✓ Have pesticides or other chemicals been sprayed in the area recently
- ✓ Lab results
- ✓ Case notes and comments

Information gathered should be displayed graphically. It should be correlated with human disease reports to allow epidemiologist to conduct case investigations that include all information. As public health implements programs to address the animal disease, the surveillance system should allow the ongoing monitoring and evaluation of the various programs.

In the case of a possible bioterrorism event, the system should support risk assessment and should be one component of an overall Epidemiologic Command Center¹



Appendix 1: OIE Diseases List A, B and C

OIE List A diseases are transmissible diseases with potential for widespread and rapid transmission. These may have serious socioeconomic or public health consequences, and are of major importance in international trade of animals and animal products. The following diseases and their International Animal Health code are in List A:

- A010 Foot and mouth disease
- A020 Vesicular stomatitis
- A030 Swine Vesicular disease
- A040 Rinderpest
- A050 Peste des petits ruminants
- A060 Contagious bovine pleuropneumonia
- A070 Lumpy skin disease
- A080 Rift Valley fever
- A090 Bluetongue
- A100 Sheep pox and goat pox
- A110 African horse sickness
- A120 African swine fever
- A130 Classical swine fever

- A150 Highly pathogenic avian influenza
- A160 Newcastle disease

OIE List B diseases are transmissible diseases, which are of socio-economic, and/or public health importance within individual countries and that are significant in the international trade of animals and animal products. This list includes about 90 diseases, categorized by animal species:

Multiple species diseases

- B051 Anthrax....

Cattle Diseases

- B101 Bovine anaplasmosis....

Sheep and goat diseases

- B151 ...

Horse disease

- B201 ...

Pig diseases

- B251 ...

Poultry diseases

- B301 ...

Lagomorph diseases

- B351

Fish diseases

- B401

Mollusc diseases

- B431 ...

Bee diseases

- B451 ...

Diseases of other animal species

- B501 ...

OIE List C diseases are transmissible diseases with important socio-economic and/or sanitary influence at the local level.

Appendix 2: "Foreign Animal Diseases"

- 1) African animal trypanosomiasis
- 2) African horse sickness
- 3) African swine fever

- 4) akabane
- 5) avian influenza
- 6) babesiosis
- 7) bluetongue and epizootic hemorrhagic disease
- 8) bovine ephemeral fever
- 9) bovine spongiform encephalopathy
- 10) contagious agalactia of sheep and goats
- 11) contagious bovine pleuropneumonia
- 12) contagious caprine pleuropneumonia
- 13) contagious equine metritis
- 14) dourine
- 15) east coast fever
- 16) epizootic lymphangitis
- 17) equine morbillivirus pneumonia
- 18) foot-and-mouth disease
- 19) foreign pests and vectors of arthropod-borne diseases
- 20) glanders
- 21) heartwater
- 22) hemorrhagic septicemia
- 23) hog cholera
- 24) Japanese encephalitis
- 25) louping-ill
- 26) lumpy skin disease
- 27) malignant catarrhal fever
- 28) Nairobi sheep disease
- 29) parafilaria in cattle
- 30) peste des petits ruminants
- 31) Rift Valley fever
- 32) rinderpest
- 33) screwworm myiasis
- 34) sheep and goat pox
- 35) swine vesicular disease
- 36) velogenic newcastle disease
- 37) Venezuelan equine encephalomyelitis
- 38) vesicular exanthema of swine
- 39) vesicular stomatitis
- 40) viral hemorrhagic disease of rabbits

<http://www.avma.org>

American Association of Veterinary Laboratory Diagnosticians <http://www.aavld.org>

American Association of Wildlife Veterinarians <http://www.aawv.net/>

American Association of Zoo Veterinarians <http://www.aazv.org>

Animal and Plant Health Inspection Service Veterinary Service (APHIS-VS) <http://www.aphis.usda.gov/vs>

Animal Health Association <http://www.usaha.org>

Association for Veterinary Informatics <http://www.avinformatics.org>

Center for Epidemiology and Animal Health <http://www.aphis.usda.gov/vs/ceah>

NAHRS <http://www.aphis.usda.gov/vs/ceah/anhrrs/index.htm>

Local and County Public Health Veterinarians
 Delegate: Dr. Vicki Giles
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National Association of State Public Health Veterinarians
 Delegate: Dr. Mary Grace Stobierski
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Office International des Epizooties (OIE): <http://www.oie.int>

Appendix 3: Important organizations and web sites

American Association of Public Health Veterinarians
<http://www.avma.org/aaphv/default.htm>

American Veterinary Medical Association The AVMA represents 85% of all veterinarians. It sponsors groups such as the Committee on Veterinary Informatics, and the Veterinary Medical Assistance Teams, which “provide zoonotic disease surveillance and public health assessment” in emergency settings.

¹ STC, “Early Warning and Detection a Key to Public Health Surveillance”, Video April 2002.

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