VETERINARY SURVEILLANCE

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Summary

Animal health surveillance has and will continue to be a vitally important component of the veterinary infrastructure supporting livestock industries, food production systems and rural economies around the world. Surveillance systems protect the health and productivity of livestock and the security of national food production systems by detecting and responding to new and changing animal diseases and food safety pathogens. Current world trade and travel patterns favor the rapid movement of people, animals (livestock and pets) and their products around the world. These patterns also facilitate the rapid movement of animal and human pathogens, resulting in more frequent introductions of new diseases into naïve human and animal populations. History, even recent history has demonstrated that the social and economic consequences of trans-boundary introductions of foreign animal diseases into livestock based food production systems can be catastrophic. Countries with intensive food production systems are at particular risk from both accidental or intentional (agro-terrorist) pathogen introductions. Intensive livestock production systems with their uniform production practices and animal genetics combined with well developed distribution systems provide conditions that are favorable for the rapid spread of newly introduced pathogens. Effective surveillance is necessary to protect food production systems and failure of surveillance systems to provide timely detection of newly introduced or emerging pathogens can result in catastrophic biological disasters that

have enormous economic and social impacts. The 2001 Foot and Mouth Disease (FMD) epidemic in the UK for example caused economic losses worth an estimated US$ 12 billion and the destruction of approximately 6.5 million animals, slaughtered for disease control and humane reasons.

1. Introduction

Animal health surveillance has and will continue to be a vitally important component of the veterinary infrastructure supporting livestock industries, food production systems and rural economies around the world. Surveillance systems protect the health and productivity of livestock and the security of national food production systems by detecting and responding to new and changing animal diseases and food safety pathogens. Current world trade and travel patterns favor the rapid movement of people, animals (livestock and pets) and their products around the world. These patterns also facilitate the rapid movement of animal and human pathogens, resulting in more frequent introductions of new diseases into naïve human and animal populations. History, even recent history has demonstrated that the social and economic consequences of trans-boundary introductions of foreign animal diseases into livestock based food production systems can be catastrophic. Countries with intensive food production systems are at particular risk from both accidental or intentional (agro-terrorist) pathogen introductions. Intensive livestock production systems with their uniform production practices and animal genetics combined with well developed distribution systems provide conditions that are favorable for the rapid spread of newly introduced pathogens. Effective surveillance is necessary to protect food production systems and failure of surveillance systems to provide timely detection of newly introduced or emerging pathogens can result in catastrophic biological disasters that have enormous economic and social impacts. The 2001 Foot and Mouth Disease (FMD) epidemic in the UK for example caused economic losses worth an estimated US$ 12 billion and the destruction of approximately 6.5 million animals, slaughtered for disease control and humane reasons.

The negative effects of trans-boundary disease introductions are not limited to industrialized countries making surveillance increasingly important to the security and economic health of livestock production systems in developing regions. Recent increases in the living standards of people in developing countries, especially Asia and South America have been accompanied by increases in demand for protein of animal origin. Some of the livestock production systems in some of these countries have responded by moving towards larger more intensive animal holdings and vertically integrated production systems. These systems are becoming just as vulnerable to new or introduced pathogens as systems in developed countries, making them equally reliant on surveillance aimed at early detection of new or introduced contagious pathogens. For example the 1997 foot and mouth disease outbreak in Taiwan resulted in the destruction of 4.3 million livestock on over 6000 infected farms.

Trans-boundary incursions of foreign diseases aren't the only disease events that can have catastrophic consequences. New, previously unknown (emerging) diseases are also capable of causing severe economic losses. Constantly changing animal rearing practices, across all levels of production intensity provides a seemingly endless opportunity or the emergence of new animal diseases. Since it's emergence in 1991, Porcine Reproductive Respiratory Syndrome (PRRS) has cost the swine industry hundreds of millions of dollars worldwide. In the USA alone PRRS is estimated to cost $US 600 million every year. Designing surveillance systems for detection of new, previously unknown diseases provides some unique challenges. It is not possible to train livestock producers and animal health professionals to be on the look out for previously unknown diseases and there are no well defined screening tests available for unknown diseases. These systems must focus on developing and maintaining an in depth understanding of normal disease patterns within populations in order to detect any abnormal patterns that may represent the emergence of a new disease. Even though there are differences in strategies for known versus previously unknown diseases, the goal of surveillance is the same: timely detection of important disease events facilitating rapid and effective responses aimed at reducing the impact of these diseases.

Endemic, well known diseases can also have severe economic consequences, especially when they change. Many important endemic diseases of intensive livestock production systems, such as undifferentiated respiratory disease in feedlot cattle, undifferentiated diarrhea of neonatal beef calves and enzootic pneumonia of young dairy calves are managed by livestock producers and their veterinarians. Even if these diseases can't be completely eradicated or prevented, producers live with them because the costs for treatments, lost animals and lost productivity are well known and can be budgeted into routine costs for production. It is when these diseases change unexpectedly that their economic costs can become unmanageable for individual producers and even livestock industries as a whole. Endemic animal disease surveillance systems are important for managing these diseases and reducing their impact on livestock production systems. The role of endemic disease surveillance is to identify diseases quickly after they change, characterize the changes and communicate this information to veterinarians and livestock producers, enabling them to develop effective control or cost mitigation strategies.

In Sub-Saharan Africa there are an estimated 25 million people that still exist as pastoralists. They are among the poorest people in the world, who struggle to maintain their lifestyle in the face of abject poverty and starvation. These people are totally dependant on their livestock for food, cash and social status, making them especially vulnerable to the effects of livestock diseases. Surveillance systems are important supporting infrastructure for these communities, providing advance warning of increased disease risks from endemic diseases such as Brucellosis, Rinderpest, Malignant Catarrhal Fever, and East Coast Fever. In many of these countries resources for disease control programs are limited, and surveillance systems play an additional important role by identifying those diseases that cause the greatest burden to livestock production systems, thereby allowing communities to more efficiently target their limited resources most effectively.

Animal health surveillance systems facilitate international trade in animals and their products. The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) which became part of the World Trade Organization (WTO) treaty in 1995 defined a basic set of food safety, animal health and plant health standards that dramatically changed the way agricultural trade disputes were settled. Prior to 1995, the precautionary principle (when in doubt, keep it out) was often used as a barrier to trade in agricultural products. Under the SPS, member countries are recognized as having the right to protect their animal, plant and public health. However, they are also obliged to demonstrate that their protective measures are not arbitrary or trade restrictive. Each member country can adopt the standards defined by the SPS, or they can develop their own more stringent standards, but they must be scientifically justified, and based on transparent risk assessment processes that define the level of disease risk within their country. Under the SPS agreement's provision of equivalence, importing countries can oblige exporting countries that wish to access their markets to demonstrate the disease risk in the animal or animal products they wish to export. Trade in agricultural products has become increasingly dependant on surveillance because national animal health surveillance efforts generate much of the animal disease information that is used to populate risk assessments and provide credibility to claims about the health and safety of animals and their products. International acceptance of a nation's claim that their livestock population is free from a trade limiting disease is dependant on several factors. Among the most important are a biosecurity system aimed at preventing the introduction of the disease into the country and a credible surveillance system aimed at identifying and responding to disease incursions and documenting that the country is free from trade limiting diseases. Surveillance systems themselves gain added importance because credible animal health information can only be produced by credible surveillance systems. Importing countries will often very carefully scrutinize all elements of an exporting country's surveillance system before accepting any claims about the health status of a population, especially when the exporting country claims freedom from an important disease.

Surveillance of free ranging animals for important diseases that affect livestock is an important part of livestock disease control or eradication programs, and is gaining importance for trade in animals and animal products. Several free ranging animal populations have recently been demonstrated to act as reservoirs for diseases for farmed livestock. Bovine tuberculosis (TB) has proven difficult to eradicate in several countries because free ranging animal populations act as reservoirs for the pathogen. Examples include badgers in the UK, possums in New Zealand, white-tailed deer in Michigan USA, and wild boar and deer in France and Spain. Demonstrating freedom from bovine TB for livestock trade, especially cattle requires enhanced surveillance on farms at greatest risk for contact with wild reservoir populations as well as surveillance of wild populations to determine the risk they pose to farmed livestock.

Animal health surveillance is also important for public health. Many animal populations play important roles in the epidemiology of zoonotic diseases. Rabies is an example of a disease that affects both humans and animals around the world, and surveillance systems that monitor submissions to veterinary diagnostic laboratories for rabies testing provide warnings to public health agencies of changes in the risk of rabies to human populations. West Nile Virus (WNV), a mosquito transmitted disease of people, birds and horses in North America, is another example. Animal and public health surveillance agencies in Canada and the United States conduct surveillance of dead birds and mosquito pools to detect WNV as indicators of the risk to local human and equine populations. Another example is bovine TB which is gaining importance as a public health concern in Africa where there is widespread consumption of raw milk, raw meat, and bushmeat as well as high levels of disease susceptibility from poverty, malnutrition and HIV infections. Food safety and meat hygiene practices are vitally important for reducing the burden of disease associated with bovine TB, as are surveillance systems that identify wildlife reservoirs and quantify the disease risk in domestic livestock. Disease control, eradication, or biosecurity programs aimed at reducing the level of bovine TB risk to the public can only be successful if they are developed in concert with animal health surveillance systems that identify infected animals or herds, and monitor the effectiveness of these programs in animals and people. In these food production systems a "one health" approach with sharing of information and resources between animal and public health providers and surveillance practitioners may provide the best chance for success.

Free-ranging animals are not the only sources or reservoirs of zoonotic pathogens. Pets because of their close relationship to humans can transmit zoonotic diseases to their owners. In many large cities around the world pets are becoming the only animals that humans interact with, and the relationship between humans and their pets is very close. In the USA children are more likely to have pets than siblings or fathers, and most pet owners consider their pets to be part of their family. Zoonoses associated with traditional pets (dogs, cats, gerbils, hamsters, goldfish) can range from simple and easily treatable diseases such as dermatophytosis (ringworm) and giardiasis, to very severe diseases such as salmonellosis and rabies. Demonstrated spatial-temporal associations between outbreaks of gastrointestinal disease in people and in pets suggests that control of some zoonotic diseases may benefit from collaboration between public health and animal health surveillance practitioners. A more concerning trend among pet owners is the increased demand for imported exotic animals for pets. As part of their natural flora, these animals may carry bacteria, viruses, fungi, parasites or other microorganisms, which local human populations have had no previous experience. Introducing exotic pets into human populations exposes these populations to new microorganisms providing an opportunity for cross infection and even evolution of these microorganisms into new zoonoses. For example in 2003 a number of people in the USA became infected with monkeypox virus from their pet prairie dogs that had been infected by Gambian pouch rats imported from Africa.

Animals and livestock production systems can play important roles as determinants of public health. Throughout the world, animal derived protein forms a varying, but often significant portion of the human diets. It would seem obvious that healthy animals are necessary for healthy food. Many human pathogens including: salmonellas, listeria, campylobacter, and E.coli O157 are transmitted by animal derived human food products. Most of these agents are non-pathogenic to the animals, making animals silent carriers. Salmonellas are of particular importance, since they subclinically infect our most important livestock species; poultry, cattle and swine and are of considerable public health concern. Concern enough for countries such as the USA, Denmark and others to implement national programs aimed at pathogen reduction in farmed livestock as a strategy to reduce the risk of salmonella in human populations. Animal health surveillance is essential for the success of these programs. Their success is heavily dependant on up to date information on changing levels of pathogens in farmed animal populations. This information is needed to evaluate the effectiveness of individual control measures, and to fine tune programs as a whole, thereby increasing the likelihood of success. The ultimate measure of success is a reduction in the burden of salmonella associated disease in human populations, making public health and animal health surveillance both important for success.

2. Definition of Surveillance

Surveillance is a concept that at first glance seems to be simple, relatively straight forward and easy to understand. Nothing could be further from the truth and no subject could be any further from simple. Scratching the surface of surveillance quickly reveals a quagmire of divergent definitions and concepts, increasingly complex and diverse but loosely associated activities, all amid a field of rapidly developing computer and internet assisted automated analytical methods that ten years ago could have been fodder for the science fiction genre.

At its most basic, animal health surveillance identifies important disease events (incursions, outbreaks, emergences) in animal populations allowing farmers, veterinarians and government disease control agencies to develop timely and appropriate responses aimed at eradicating, controlling or mitigating the adverse effects of these diseases. According to Merriam-Webster the word surveillance originates from the French word *surveiller*, ‘to watch” and is defined as: “close watch kept over someone or something (as by a detective)”. This definition seems relatively straightforward and uncomplicated and at first glance would seem to be a good fit for animal health surveillance. We could imagine an animal health surveillance definition being: “close watch over an animal population”. And in fact animal health surveillance does watch over animal populations, but that is only part of what animal health surveillance does. As the fields of animal and public health surveillance have grown, especially in recent times, they have quickly exceeded the limitations of this simple definition. Today many definitions for surveillance exist in both public and animal health domains, creating a lot of confusion, and making it difficult to select a single definition that fits all surveillance activities.

Although there are differences in these definitions all would suggest that surveillance is made up of component activities that would include the following:

1. Detection

Continuously observing a population and/or collecting, analyzing and interpreting data from a population for the purpose of timely detection or identification of:

- important disease events in the population
- significant changes in the health status of the population
- significant changes in risk factors for diseases in the population

2. Response

Timely and appropriate response to important diseases or changes in health status, aimed at mitigating the effects of disease and improving the health of the population

3. Information production and communication

- Production of information about the health and disease status of a population and communication of this information to stakeholders and decision makers to support the development of evidence based strategies and policies for disease eradication, control, or mitigation, and enhancement of the overall health of the population.
- In the context of animal based food production systems, surveillance must produce information documenting the health of animal populations, safety of animal products, and the validity or credibility of the surveillance system itself in order to facilitate international trade, access to markets and consumer confidence in food of animal origin.

The ultimate goal of all these surveillance activities is of course to reduce the burden of disease within a population. While public health surveillance is concerned primarily with the burden of disease in human populations, animal health surveillance has a much wider scope than just animal health. Since animals can act as reservoirs for human pathogens, animal health surveillance is also concerned with the health of human populations. Animals are also raised for human food production, and since diseases of animals can affect the safety of human food, animal health surveillance systems are often concerned with food safety. Based on these activities a single sentence definition for animal health surveillance might read something like:

The systematic and continuous observation of animal populations or food production continuums, and/or the collection, analysis and interpretation of data from many varied sources, for the rapid detection and timely appropriate response to important animal health and food safety events, and the production and communication of information about the health of animal populations and the safety of animal products.

3. Purpose and Goals of Surveillance

The purpose of animal health surveillance is to enhance public health by improving the health, productivity, efficiency and economic viability of livestock based food production continuums, reducing the burden of disease from food borne human pathogens, and reducing the burden of zoonotic diseases on human populations. High level goals of surveillance are to assess the current disease or pathogen status of food production continuums, rapidly identify and respond to changes in that status, and produce information documenting the health of the animals, pathogen status of the food production continuums and validity of the surveillance system. Surveillance systems are always designed and implemented to meet specific goals. Since these can vary greatly across jurisdictions, livestock industries and diseases, it is not possible to provide an exhaustive list of the specific goals of surveillance. Some of the more common goals or outcomes of animal health surveillance are a direct result of developing the capacity for:

1. Timely detection and rapid appropriate response to newly emerging diseases, changing endemic diseases and incursions of trans-boundary diseases that will:

- Minimize the effect of these diseases on livestock production systems
- Strengthen rural economies by minimizing the effect of these diseases

- Enhance food security by minimizing the effect of unintentional and intentional (agro-terrorist) introduction or emergences of these diseases
- Improve access to markets for animals and their products

2. Timely detection and rapid appropriate response to the introduction of food borne pathogens into animal based food production continuums that will:

- Improve public health
- Improve consumer confidence in the safety of animal derived food products resulting in enhanced markets for these products and strengthened rural economies
- Improved security of food production continuums by mitigating the risk of the introduction of bio-terrorist agents

3. Timely detection and rapid appropriate response to zoonotic diseases that will:

- Improve public health
- Reduce the occupational health risk to farmers, animal handlers, veterinarians and others working directly with farmed animals

4. Estimating the amount and distribution (temporal and geographic) of disease and risk factors for disease that will support:

- Increased access to markets by documenting the absence of diseases that affect trade
- Effective biosecurity and disease control programs by evaluating and fine tuning these programs
- Appropriate animal health research programs by prioritizing animal diseases by their importance

5. Producing valid information on animal diseases and risk factors of animal diseases that will support:

- Development of risk assessment to support trade in animals and animal products
- Development of informed, evidence based disease control policy
- Development of epidemiological models that facilitate predictions of the location and likelihood of future outbreaks of endemic diseases
- Development of informed Foreign Animal Disease emergency response plans

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Biographical Sketch

John Berezowski grew up on a mixed farm in Eastern Saskatchewan and graduated from the Western College of Veterinary Medicine in 1981. He spent the next 18 years working in mixed animal practices in Saskatchewan and Northern Alberta, where his major interests were cow-calf and alternative livestock practice. In 1999 he returned to the Western College of Veterinary Medicine and began working towards completion of his PhD in veterinary epidemiology. In 2003 he joined the Food Safety Division of Alberta Agriculture and Food where he happily spends most of his time developing surveillance systems for Alberta's livestock industries.