Integration of animal health, food pathogen and foodborne disease surveillance in the Americas

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Summary
This paper describes the characteristics of surveillance and the attempts made in the Americas to institute truly integrated surveillance systems that bring together disease surveillance of medically treated clinical populations with disease surveillance for food-production animals. Characteristics of an ideal, integrated food safety system are described. Systematic surveillance programmes in the Americas vary widely in scope and reliability, and none is fully integrated. Estimates of foodborne disease rates, particularly in North America, are becoming increasingly accurate, and programmes such as those promoted by the Pan American Health Organization are gradually leading to improvements in estimates of the foodborne disease burden in Latin America. Linking foodborne diseases to their sources is necessary for reducing disease incidence, and the World Health Organization’s Global Foodborne Infections Network is building global capacity in this area. Activities in these areas in the Americas are described in detail.

There is now clear recognition that there are dynamic links between infectious diseases occurring in wildlife and livestock and those occurring in humans, and this has led to calls from organisations such as the US National Academy of Sciences and the American Veterinary Medical Association to integrate surveillance programmes for zoonotic and human diseases. Models for the development of such integrated programmes, at local, national and international levels, are described. To be effective, such models must incorporate programmes to capture information from numerous, discrete surveillance systems in a way that allows rapid analysis to identify zoonotic and human disease connections. No effective integration now exists, but there are signals that governments in the Americas are working together towards this goal.

Keywords

Introduction
Surveillance activities in the human and animal health realms are essential for accomplishing several objectives. First, they contribute to identifying pathogens and exposure routes. This is necessary to shape an effective response to a public or animal health event. Secondly, the information gleaned from an investigation can help to suggest preventative controls and management measures. Finally, surveillance activity provides data essential for measuring the effectiveness of macro-level control programmes, such as those operating across an industry or government-wide.

According to the Institute of Medicine (United States), surveillance data originate from three primary sources:
– outbreak investigations
– passive surveillance
– active surveillance (10).
In the United States (USA), clinical laboratory isolates are frequently used as the core data points that identify a continuing outbreak. Tracking illnesses through monitoring laboratory findings is crucial when illnesses are not localised.

Laboratory-based surveillance systems have been effective in the USA, a large country with relatively centralised food production and a sophisticated transportation system for the nationwide distribution of products. Contaminated foods can be rapidly dispersed around the country before an event is even discovered. Clinical samples are analysed using sophisticated laboratory-based systems that can compare isolates through pulsed-field gel electrophoresis (PFGE) or other genetic typing methods (e.g. multi-locus sequence typing), to identify common patterns among the pathogens that are causing illnesses. Once an outbreak is identified, local investigators interview the consumers who became ill to try to identify a common food source, usually by contrasting these individuals’ food consumption habits with those of a suitable control group. Where sophisticated laboratory systems are not available, public health officials may identify an outbreak when a large number of people become ill and then use interviews to identify a common exposure, such as a water source or food consumed at a large gathering.

In the field of antimicrobial resistance, integrated surveillance systems are being developed to monitor resistant strains from multiple sources, including livestock, meat and human clinical isolates. These isolates are then used to make links and aggregate data in a system called ‘integrated surveillance’. These systems are in use in several European countries and are being piloted in the Latin American region and other developing regions by the World Health Organization (WHO) (26).

Foodborne-disease surveillance – current approaches

Surveillance systems are defined as those that collect and analyse morbidity, mortality and other relevant data, linking diseased patients to food sources and, ideally, tracing an outbreak back to its origin, making data rapidly available to decision-makers (17, 21).

In a fully functioning surveillance system, routine data collection and analysis are followed by responses that will enable investigators to remove contaminated food from the market to minimise illnesses. According to the United States Centers for Disease Control and Prevention (CDC), timely decisions and responses based on data analysis are the characteristics that distinguish surveillance from monitoring, which tends to emphasise an accurate description of events, based on more passive analysis and reporting (7, 22).

Robinson et al. (15) emphasise the systematic nature of surveillance. Because of its end use – to aid the planning, implementation and evaluation of public health programmes – data recording must be standardised, along with case definitions of the events being studied. Good surveillance provides a statistical description of ‘what is normal’, and it is these descriptions – the systematology of surveillance – that enable us to detect the deviations from normality caused by an outbreak.

As this paper demonstrates, surveillance efforts at national levels vary widely in their adequacy and reliability, limiting our ability to integrate their data. Furthermore, the past decade has seen the appearance of new foodborne zoonoses, while older pathogens that were thought to have been controlled are reappearing through new exposure routes (15). For example, Toxoplasma gondii, previously thought to present a hazard only to pregnant women who clean cat litter boxes, is now recognised as a disease that can be transmitted through pork.

For the purposes of this review, foodborne diseases include those related to food that has become contaminated with pathogenic microorganisms. Many foods, of both animal and plant origin, can be contaminated by disease-producing microorganisms at one or more stages of food production, beginning on the farm and ending in the home. While livestock and other domestic animal sources are often implicated, the ultimate sources of contaminants can extend back to infected feral or wild animals. Current models for controlling foodborne diseases emphasise identifying the food animals that carry the disease-producing organism, preventing the contamination of the food products, and prohibiting market entry of any products that do become contaminated.

According to WHO, more than two million deaths occur each year because of diarrhoeal diseases associated with food and water contamination (24). Documentation of the total global burden of morbidity and mortality from foodborne diseases, which is certainly enormous, is incomplete and highly uneven in many regions; indeed, in some countries, virtually no data are available from official reporting programmes. In a recent study of informal food and waterborne disease reporting from the seven world regions used by WHO to study global disease burdens, several regions, including Latin America, were found to provide few data (17). The study concluded that a systematic and continuous review of informal reporting provided useful data in the region. Non-traditional sources of more informal surveillance information have also been useful in the animal health arena. Livestock owners with
considerable experience may be very good at describing disease signs, along with hunters, community animal health workers and abattoir workers. Such sources may prove especially valuable in developing countries, and can benefit from modern technologies, such as mobile phones, that make rapid information-sharing possible (11).

Estimates of foodborne disease rates in North America are readily available. The CDC estimate that there are 48 million cases of illness, with 128,000 people hospitalised and 3,000 deaths, annually (6). Such estimates are less common in most areas of South and Central America and the Caribbean, although the situation in these regions is beginning to change.

The intensive work in the USA to develop sophisticated analytical tools to develop ‘burden of disease’ estimates is quite important, as it represents some of the most innovative work in developing population estimates for large, regionally diverse countries. In 2006, WHO launched the Foodborne Disease Burden Epidemiology Reference Group (FERG), in collaboration with international stakeholders and WHO’s Department of Food Safety, Zoonoses and Foodborne Diseases, to build a framework estimating the global burden of foodborne disease (23). In the North American region, the USA estimates provide important baseline data for developing the regional estimate, since the USA accounts for a majority of the population of North America.

Characterising the problem by using aggregate estimates is important to establish a political basis for providing support and funding to address food safety problems at the governmental level. However, such estimates do not provide specific information on what steps are needed to address such problems. Much greater detail about many variables – some of them possibly not now recognised as important – is needed to answer questions such as the proportion of illnesses attributed to animal products (meat, poultry, seafood, dairy) and those attributed to non-animal products (fruits and vegetables, grains) or the percentage of illnesses that result from domestically produced foods versus imported products.

Evaluating the contribution that different foods make to foodborne illness, described in the literature as ‘food attribution’, is important for integrated surveillance systems. One North American outbreak database, in the USA, contains information on more than 7,100 outbreaks from known food sources and pathogens covering 20 years (5). Eight of the 12 food categories reported in this database are animal products (e.g. beef, pork, poultry, eggs, dairy) which have been shown to be significant in contributing to outbreaks of foodborne disease. The annual summary provides reports on outbreak trends, broken down into each major food category, and the most common aetiologies linked to each food category, as well as overall trends in human disease over the period examined (6). A similar Latin American and Caribbean database reported over 6,000 outbreaks from 20 countries and observed fluctuations in both the pathogens and food products identified as the most important sources of disease (14).

In the USA, FoodNet, a CDC unit, and PulseNet, a network of laboratories coordinated by the CDC, capture sporadic illness data linked to zoonoses and show the large volume of illnesses that are not linked to outbreaks. FoodNet findings are presented annually and are useful in determining trends over time in the sporadic incidence of Salmonella, Campylobacter, pathogenic Escherichia coli and other foodborne pathogens. Data collected from FoodNet sites include patient demographics, co-morbidities, hospital-stay details and other characteristics of the pathogens, e.g. serotyping (7, 16). Notably, neither FoodNet nor PulseNet include systematic characterisation of the food associated with the foodborne disease, or ‘food attribution’.

The WHO Global Foodborne Infections Network (GFN) is building the global capacity to detect and control foodborne disease, and its country databank now contains large volumes of data, from reference laboratories in 83 countries, on the 15 most common Salmonella enterica serovars isolated from human and non-human sources. All Western Hemisphere regions are represented in this database, which has been undergoing continuous improvement since 1985. The data are publicly available (25) and their analysis could assist greatly in understanding the global dynamics of foodborne disease related to Salmonella.

The Pan American Health Organization (PAHO) has taken major steps to strengthen foodborne disease surveillance in the Americas and to assist in the development of national food safety systems. Moreover, PAHO and WHO have collaborated in the development of a number of Collaborating Centers in the Americas, to assist in improving foodborne disease surveillance and reporting throughout the region (13).

Another programme of interest in the USA is the National Antimicrobial Resistance Monitoring System (NARMS). This project monitors changes in the antimicrobial susceptibility of foodborne zoonotic pathogens in humans and animals (20, 26). More generally, government agencies also study the relatedness of foodborne pathogens found in contaminated meats and infected humans by comparing their PFGE patterns (1, 3).

It is the purpose of the remaining sections of this review to look beyond these developing efforts, and to investigate whether food safety systems might be further enhanced by adopting the tools and methods of zoonotic disease surveillance.
The situation in the Americas

While North America has some robust surveillance programmes, they are not well integrated. To understand the challenges behind improving surveillance, it is important to understand the nature of the information flow, which originates at the local level where the illnesses and outbreaks occur. Information can be captured at the local level but not shared with other government agencies. Information on larger outbreaks often flows up to a higher governmental level, such as a provincial or state government. At this level, it can be aggregated in a data management system, and perhaps shared further. Finally, information about the outbreak can come to the attention of national public or animal health authorities. This occurs most frequently for events that are large and hard to contain.

In the USA, significant strengthening of the passive system of federal and state surveillance was achieved when the CDC implemented the National Notifiable Disease Surveillance System, requiring all states to report infectious diseases, including zoonoses, to the CDC. In 1998, the CDC adopted an active surveillance system, FoodNet, designed to collect population-based data from nine specific sites and described above (7). In addition, the USA has numerous federal, state and local veterinary surveillance programmes. Most states have a designated Public Health Veterinarian or Chief Veterinary Officer, who has a high-level role in surveillance. The importance of astute and observant veterinarians and physicians in private practice and their willingness to participate in the surveillance system cannot be over-emphasised.

PulseNet Canada (established in 2000) is a virtual electronic network linking the public health laboratories and databases of all provinces, as well as some federal laboratories, through the Public Health Agency of Canada’s National Microbiology Laboratory in Winnipeg, Manitoba. The network is designed to track the PFGE patterns of all cases of foodborne *E. coli* and *Salmonella* in Canada and to harmonise foodborne illness data across North America through close cooperation and data-sharing with the US PulseNet system.

The Canadian Integrated Public Health Surveillance (CIPHS) programme fosters a strategic alliance among public health and technology professionals to build integrated public health database tools for use by Canadian public health professionals. These tools are designed to collect and collate the health surveillance data generated by the normal work of public health professionals, and to aggregate these data to support evidence-based public health decisions in Canada. The CIPHS programme can report, query, share data and help manage cases across numerous jurisdictions by relaying information to case investigators (4).

The PulseNet laboratory centres of Latin America and the Caribbean were established at various times throughout the 1990s. While individual countries in Latin America and other regions show emerging skills in surveillance, a review of all peer-reviewed publications resulting from the work of the GFN showed that, of 28 papers published between 2000 and 2011 (many from laboratories in Asia), none described collecting data with the intention of sharing (or integrating) information with clinical data collected through medical surveillance (25).

Vrbova et al. (21) conducted a systematic review of peer-reviewed articles that described and evaluated surveillance systems for emerging zoonotic diseases. They found that, between 1992 and 2006, only 17 of 221 identified systems were formally evaluated. The fact that most systems are not subjected to formal evaluation limits the ability of decision-makers to understand their actual effectiveness. More importantly, perhaps, the authors noted that many systems claimed to be surveillance systems, but Vrbova and colleagues suspected that many fell short of that definition, and were instead monitoring systems. This review also illustrated the wide disparity between the relatively more developed countries of Canada and the USA and the relatively less developed countries of Latin America, describing the current approach taken in Latin American countries as monitoring rather than actual surveillance.

### Table I

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<th>Continent</th>
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<th>Known and unknown pathogens</th>
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Surveillance in the Americas is further described by Smith DeWaal et al. (18). The authors collected 416 reports of foodborne and waterborne outbreaks, in English, from six world regions during the calendar year. Outside North America (see note below), only three regions were found to have collected data that were adequate to allow comparisons. The greatest number of reports came from Africa, with 128, the Western Pacific contributed 118 reports, and Europe, 97 reports. In the same period, only ten reports were available from the Latin American region. (NB: The absence of reports from North America was explained by the authors – ‘Because the researchers were situated in, and focus extensively on the food safety issues and policies in, the North American region, that region was not included in this study in order to neutralise any North American bias of the results.’)

Non-traditional or ad hoc approaches to surveillance can be used as surrogates for more established and conventional surveillance programmes, especially in countries with significant public health resource constraints. Although the following examples have been applied to zoonoses that are not food safety hazards, they could just as well be adapted for use with foodborne disease zoonoses. For example, sentinel surveillance programmes have been used for many years to identify arbovirus activity through periodic serological examinations of free-flying birds, such as seagulls or pigeons, or caged chickens. A human case of brucellosis in a designated Brucella-free district may be a sentinel for ‘below the radar’ prevalence of animal brucellosis or the re-introduction of the disease into a previously disease-free zone (7).

The Food and Agriculture Organization of the United Nations (FAO) has tested mobile phone-based approaches to surveillance that take advantage of the fact that, in developing countries, cellular telephone networks often have good signal coverage over wide areas, enabling rapid connection in the field, whereas, in those same countries, access to the Internet can be difficult, especially in rural areas. A good example is the FAO Global Animal Disease Information System (EMPRES-i). One FAO development is the EMPRES-i Event Mobile Application (EMA app.), which the FAO has been testing as a means of reporting emergency disease information to EMPRES-i. The mobile application allows users with Blackberry™ devices and Android™ smartphones to enter epidemiologic data directly from the field. The data are automatically geo-referenced, and could ultimately feed into the FAO/World Organisation for Animal Health (OIE)/WHO Global Early Warning System (GLEWS) platform.

Table I, adapted from Vrbova’s study (21), illustrates the state of surveillance programmes in Central and South America.

Constraints on the resources set aside for public and animal health programmes effectively demand the development of more integrated, risk-based surveillance approaches, enabling collection of the greatest amount of high-quality data through the lowest-cost technologies, with wider applicability. For example, Morris et al., cited in (7), propose designing surveillance systems that are based on geographical information systems and include temporal marking. New approaches to surveillance can include surveillance as a component of epidemic and endemic disease control programmes or – the opposite approach – targeted surveillance to answer specific questions about specific diseases. Food safety surveillance programmes would need to be designed to collect data effectively on zoonotic pathogens that do not typically cause animal disease.

In Canada, CIPHS is attempting to incorporate human, animal, food and environmental data to create a truly integrated database, which would support a truly integrated surveillance programme (4). Indeed, a review of surveillance systems around the world produced for the Canadian government (21) concluded that there is movement towards greater integration of animal and human surveillance. Of the 221 systems reviewed in that study, nearly half looked at human data alone, 22% looked at animal data alone, and 16% tracked both animal and human data. Within the latter group, most focused on West Nile virus in North America, where human diagnostic data were in the same system as bird and mosquito data.

It remains the case, however, that cultural, budgetary and ‘turf’ or territorial differences continue to impede the integration of animal and human disease surveillance systems into a truly integrated ‘One Health’ system, as no explicit mandate exists to override these historical divisions. Ultimately, formal legislation (and companion budget appropriations) would be required to force the development and maintenance of integrated, risk-based surveillance systems.

Relationships between zoonotic disease surveillance and foodborne diseases

Asymptomatic infections in food animals are the most distal and traceable causes of significant rates of foodborne disease, perhaps most of it. Cattle infected with *E. coli* O157:H7 and chickens infected with *Salmonella Enteritidis* rarely show clinical signs of disease (9), but these organisms are highly important causes of foodborne disease. The situation is similar for *Campylobacter, Vibrio* and most other known causes of foodborne illness. These infections can
readily be detected in animal organs and tissues (8), and in the USA and some other countries, monitoring of both live and slaughtered animals for E. coli O157:H7 and Salmonella is part of the current food safety inspection programmes, with infected meat products being routinely condemned or recalled. Yet many cases of disease due to these organisms still occur. There appears to be no published analysis of attempts to correlate rates of infection in live animals and rates of food contamination or of related foodborne diseases. Such analyses might reveal the value of live-animal infection surveillance.

The wide recognition that there are ongoing and dynamic links between infectious diseases occurring in wildlife, livestock and humans has created an intense focus on zoonotic disease surveillance. Theoretically, by systematically collecting data on the occurrence of infectious diseases in humans and animals, and analysing their occurrence over space and time, it may become possible to provide early warning signals to human and animal health officials. A number of international agencies, as well as the US National Academy of Sciences (12) and the American Veterinary Medical Association (2), have developed strategic frameworks which, if applied, may be effective at reducing the risk of zoonotic diseases.

Despite this high-profile attention directed at early warning systems for emerging zoonotic diseases, the National Academy of Sciences found that the traditional systems for human and animal disease surveillance, even in the USA, operate quite separately. In fact, its Committee was unable to identify a single example of a zoonotic disease surveillance system that effectively integrated findings from both animal and human health programmes. The Committee made no mention of whether it could identify any such integration in the area of foodborne disease surveillance, but presumably it does not exist or is similarly ineffective (12).

These results are demonstrated in the Americas: while the USA and other industrialised countries have relatively well-developed human and animal disease surveillance systems in place, integration of the two, except in isolated cases, remains incomplete. Most recent zoonotic diseases have emerged in the developing world, where both types of disease surveillance systems are relatively weak.

Veterinary surveillance programmes track diseases important for animal health. For example, the GLEWS project for major animal diseases (27) lists 19 zoonotic diseases/infectious agents, only two of which – brucellosis and bovine spongiform encephalopathy (BSE) – have been reported to cause foodborne disease, and those reports, while serious, do not account for the vast majority of foodborne diseases.

### Some characteristics of a truly integrated One Health animal–human (veterinary–clinical) zoonotic disease surveillance programme

Knowledge about the incidence of disease at the human, animal and environmental interface is essential for devising strategies to reduce the occurrence of such diseases. In today’s world, those strategies must operate at the local, national and international levels: pathogens that originate in animals and birds already find their way into the food or water supply and pose a huge public health burden, according to WHO estimates (19).

Reliance on imported foods allows pathogens to move readily via commerce. While importing countries monitor their food imports to prevent the entry of contaminated products, it would be much more effective to rely on efficient surveillance and control systems in other countries to help control the flow of goods and animals. Preventing foodborne disease is complicated by the fact that the rates or even types of foodborne pathogens found in one country or geographic region often differ from those of other (importing) countries.

Developing effective models for integrated surveillance is important for managing the flow of information through numerous separate surveillance systems at the local and national levels. Improving surveillance will require information to be gathered from these systems and integrated with the information flowing from corresponding systems in the human, animal and wildlife sectors.

Infrastructure characteristics that should be considered when establishing integrated surveillance systems include robust data management systems that capture information from human and animal outbreak surveillance, laboratory results from hospitals and veterinarians, food-testing data, and early warning systems for new and emerging pathogens.

Frameworks for integrated surveillance systems are being developed by WHO with the aim of monitoring antimicrobial resistance in human pathogens isolated from livestock, food and humans, as well as monitoring the use of antimicrobials in the animal production sector (26). These programmes aim to demonstrate relevant connections between the use of antimicrobials in the animal population and the presence and levels of antimicrobial-resistant pathogens in the food supply. They are being piloted in both developed and developing countries, including several Latin American countries.
While information-sharing systems are being highlighted at the international level, as seen in the Americas, they have yet to be widely adopted at the national level, regardless of whether a country is developed or developing. Emphasis should be given to designing models for information sharing that can ensure that the information from surveillance systems is accessible, comparable and readily available to decision-makers. They, in turn, must use these data to monitor existing conditions, analyse baselines and initiate appropriate regulation to further the protection of human and animal health and well-being.

Surveillance intégrée de la santé animale, des agents pathogènes présents dans les aliments et des maladies d’origine alimentaire aux Amériques

K. Hulebak, J. Rodrigs & C. Smith DeWaal

Résumé
Le présent article expose les caractéristiques de la surveillance sanitaire aux Amériques, ainsi que les tentatives qui y sont effectuées pour instituer des systèmes de surveillance véritablement intégrés qui couvrent à la fois les maladies des populations humaines affectées cliniquement et bénéficiant d’un traitement médical et celles des animaux destinés à la production alimentaire. Les caractéristiques décrites sont celles d’un système intégré idéal de sécurité sanitaire des aliments. Les programmes de surveillance systématique appliqués aux Amériques ont une portée et une fiabilité très variées, et aucun d’eux n’est pleinement intégré. Les estimations afférentes aux taux de maladies d’origine alimentaire gagnent en précision, en particulier en Amérique du Nord, et les programmes, à l’instar de ceux encouragés par l’Organisation panaméricaine de la santé, conduisent progressivement à l’amélioration des estimations de l’impact des maladies d’origine alimentaire en Amérique latine. Il est indispensable de pouvoir remonter à la source des maladies d’origine alimentaire si l’on souhaite réduire leur incidence. Le Réseau mondial des infections d’origine alimentaire (GFN) de l’Organisation mondiale de la santé œuvre actuellement au renforcement des capacités mondiales en la matière. L’article présente en détail les actions menées aux Amériques dans ce domaine.

Aujourd’hui, il est clairement admis qu’il existe des liens dynamiques entre les maladies infectieuses apparaissant chez la faune sauvage et les animaux de rentes, d’une part, et celles survenant chez l’homme, d’autre part. Ce constat a amené les organisations telles que l’Académie nationale des sciences et l’Association américaine de médecine vétérinaire aux États-Unis, à intégrer des programmes de surveillance couvrant les maladies zoonotiques et humaines. Le présent article met en avant des modèles permettant de développer de tels programmes intégrés aux niveaux local, national et international. Afin de gagner en efficacité, ces modèles doivent incorporer des programmes permettant de recueillir des informations émanant d’une multitude de systèmes de surveillance particuliers, de manière à pouvoir effectuer une analyse rapide et identifier ainsi tout lien entre une maladie zoonotique et une maladie humaine. Bien qu’à l’heure actuelle il n’existe aucun système véritablement intégré, de nombreux signes tendent toutefois à montrer que les gouvernements aux Amériques collaborent à cette fin.

Mots-clés
Integración de la vigilancia de la sanidad animal, los agentes patógenos de los alimentos y las enfermedades transmitidas por los alimentos en las Américas

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Resumen
Este artículo describe las características de la vigilancia y los intentos llevados a cabo en las Américas de instaurar sistemas de vigilancia realmente integrados, que sirvan al mismo tiempo para la vigilancia de enfermedades en poblaciones afectadas clínicamente y sometidas a tratamiento médico y para vigilar enfermedades en animales destinados al consumo humano. Se describen las características de lo que sería un sistema integrado ideal de inocuidad alimentaria. En las Américas, el ámbito de aplicación y la fiabilidad de los programas sistemáticos de vigilancia varían mucho en función de cada caso, y ninguno de estos sistemas es totalmente integrado. Las estimaciones de las tasas de enfermedades transmitidas por los alimentos, en concreto en Norteamérica, cada vez son más exactas, y programas como los que promueve la Organización Panamericana de la Salud están mejorando cada vez más las estimaciones de la carga de enfermedades transmitidas por los alimentos en Latinoamérica. Para reducir la incidencia de las enfermedades transmitidas por los alimentos es necesario establecer cuál es su origen, y la Red Mundial de Infecciones Transmitidas por los Alimentos, de la Organización Mundial de la Salud, está trabajando para la capacitación en este ámbito a nivel mundial. Se describen en detalle las actividades que se llevan a cabo en estos sectores en las Américas. Ahora se reconoce claramente que existe una relación dinámica entre las enfermedades infecciosas que tienen lugar en la fauna salvaje y en el ganado y las que aparecen en el ser humano, y ello ha comportado que organizaciones como la Academia Nacional de Ciencias de EE.UU. y la Asociación Americana de Veterinarios integren programas de vigilancia de enfermedades zoonóticas con programas de vigilancia de enfermedades humanas. Se describen modelos para el desarrollo de este tipo de programas integrados, a nivel tanto local como nacional e internacional. Para que sean eficaces, estos modelos deben contar con programas de captación de información que proceda de muchos sistemas distintos de vigilancia, de forma tal que se pueda llevar a cabo un análisis rápido para detectar conexiones entre enfermedades zoonóticas y enfermedades humanas. Por el momento, no existe ninguna integración eficaz, pero sí indicios de que determinados gobiernos de las Américas están trabajando conjuntamente para lograr este objetivo.

Palabras clave
References


