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Public health impact of zoonoses and international approaches for their detection and containment

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Summary
Many new, emerging and re-emerging diseases of humans are caused by pathogens that originate from animals or products of animal origin. A wide variety of both domestic and wild animal species act as reservoirs for these pathogens, which may be viruses, bacteria or parasites. Given the extensive distribution of the animal species affected, the effective surveillance, prevention and control of zoonotic diseases pose a significant challenge. There are direct and indirect implications for public health of emerging zoonoses. Direct implications are defined as the consequences for human health in terms of morbidity and mortality. Indirect implications are defined as the effect of the influence of emerging zoonotic disease on health professionals and the general public. The tremendous indirect impact of emerging zoonotic diseases on public health policy and structures and on public perception of health risks is acknowledged. A biphasic approach for handling emerging zoonoses is proposed, i.e. a short- to intermediate-term response to an outbreak or emergency and a long-term comprehensive study of the ecology of the zoonotic pathogen. Resource-rich countries should invest in the establishment and strengthening of surveillance systems in resource-limited countries considering the international significance of emerging zoonoses. Based on the new international health regulations, emphasis should be placed on building the appropriate preparedness and response capacity in countries and on promoting intersectoral collaboration and coordination.

Keywords
Animal, Disease, Health, Public Health, Zoonosis.

Impatto delle zoonosi sulla sanità pubblica e approcci internazionali per il loro riconoscimento e controllo

Riassunto
Molte tra le nuove patologie umane, emergenti e riemergenti, sono causate da patogeni che derivano dagli animali o dai prodotti di origine animale. Molte specie animali, sia domestiche che selvatiche, rappresentano un serbatoio per questi patogeni: virus, batteri o parassiti. In considera-zione della vasta distribuzione delle specie colpite, una sorveglianza efficace, la prevenzione e il controllo delle zoonosi rappresentano una vera e propria sfida. Le implicazioni delle zoonosi emergenti sulla sanità pubblica sono dirette e indirette. Sono definite implicazioni dirette quelle che hanno conseguenze per la salute umana in termini di morbilità e mortalità. Implicazioni indirette sono definite gli effetti dell'influenza delle zoonosi emergenti sugli operatori sanitari e sul grande pubblico. Viene riconosciuto l'enorme impatto indiretto delle zoonosi emergenti sulla politica di sanità pubblica, sulle strutture e sulla percezione pubblica del rischio sanitario. In questo lavoro viene proposto un approccio bifasico per gestire le zoonosi emergenti, come ad esempio una risposta a breve-medio termine in caso di focolaio o evento emergente; uno studio a lungo termine per l'ecologia dei patogeni zoonosici. I paesi ricchi di risorse dovrebbero

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investire nella costruzione e nel rafforzamento di sistemi di sorveglianza nei Paesi a risorse limitate, proprio in considerazione del peso internazionale delle zoonosi emergenti. Sulla scorta delle nuove norme internazionali sanitarie sarebbe necessario porre l'enfasi sull'implementazione di una preparazione adeguata e di una capacità di risposta nei vari paesi e sulla promozione di collaborazione e coordinamento intersettoriali.

Parole chiave
Animale, Malattia, Salute, Sanità Pubblica, Zoonosi.

Introduction

Emerging zoonotic diseases are increasingly recognised as being of global and regional importance with potentially serious human health and economic impacts (3, 20, 21, 27). Their current upward trends are likely to continue (4, 18, 35). During recent decades, many previously unknown human infectious diseases have emerged from animal reservoirs, from agents such as human immunodeficiency virus (HIV), Ebola virus, West Nile virus, Nipah virus, Hanta virus and, more recently, severe acute respiratory syndrome (SARS) and H5N1 highly pathogenic avian influenza (HPAI) viruses (8, 14, 16, 19, 26, 32). In 2004, the World Health Organization (WHO), Food and Agriculture Organization (FAO) and World Organisation for Animal Health (*Office International des Épizooties*: OIE) adopted a common definition, as follows: 'an emerging zoonosis is a zoonosis that is newly recognised or newly evolved, or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range'. Many zoonoses that are endemic but epidemic-prone such as leptospirosis, brucellosis and rabies would, therefore, also fit the definition (28, 35). In addition, as demonstrated by HPAI in birds, emerging diseases of yesterday may rapidly become endemic diseases of today.

Although history shows that the cascade of events leading to the emergence of a new disease is different each time, several factors are known to favour such emergence. These include microbiological adaptation, environmental changes, globalisation of agriculture, food production and trade and human behavioural factors (12, 22). Predicting which zoonotic diseases may emerge in the future is obviously extremely difficult, due to the multifactorial and constantly evolving nature of the risk factors involved. Vector-transmitted infections may be the exception, as they are strongly influenced by environmental factors (23, 34).

In these conditions the early and accurate detection of new outbreaks of epidemic diseases, including emerging zoonoses, and an improved capacity to understand the underlying causes of the emergence of disease and the ecology of the agents and their hosts will assist in the effective prevention or rapid containment of future emergence events.

International networks for diseases detection and containment

Integrating the early warning, alert and response systems of international organisations should be undertaken to facilitate early detection of outbreaks of communicable diseases of international public health importance. To achieve this goal, a number of international networks have been established in recent years to better detect and respond to such events. Some of these networks, such as the global early warning system for transboundary animal diseases (GLEWS) (FAO/OIE/ WHO) (36) and international food safety authorities network (INFOSAN) emergency (WHO/FAO) (39), global alert and response network (GOARN) (WHO and national institutions) (38) focus on early detection and response in outbreak situations, whereas others, such as the International Health Regulations (IHR) (WHO), global framework for transboundary animal diseases (GF-TADS) (FAO/OIE) (11), global diseases detection (GDD) programme (Centers for Disease Control and Prevention: CDC) have, in addition, a strong national capacity building component (30). GLEWS provides a valuable platform that builds on the added value of

combining and coordinating the alert mechanisms of the OIE, FAO and WHO to assist in prediction and, ultimately, the prevention and control of animal disease threats, including zoonoses. INFOSAN is a network that promotes the exchange of food safety information and improves collaboration between food safety authorities at national and international levels. 'INFOSAN emergency' is a component for natural, accidental or intentional contamination of food that requires urgent action. The GOARN is a network coordinated by the WHO with existing national institutions and international or regional networks that provides an operational framework to link expertise and skills to keep the international community constantly alert to the threat of outbreaks and to ensure all parties are ready to respond. GOARN assists countries with disease control efforts by ensuring appropriate and rapid technical support to affected populations, investigates and characterises events and assess risks of rapidly emerging epidemic disease threats, including those caused by agents of animal origin that are either zoonotic or have zoonotic potential.

The purpose and scope of the 2005 IHR (29, 37), an international legal instrument, are to prevent and control the international spread of disease by providing an appropriate public health response. Under the IHR, emphasis must be placed on building the appropriate preparedness and response capacity in countries and linking the capacity to regional and international networks.

New mechanisms for early warning and surveillance for a timely response

New mechanisms for early warning, surveillance and response are required using new approaches (e.g. syndromic surveillance), new tools (e.g. geographic information systems, mathematical modelling and satellite remote sensing data) (1, 2, 17). The study of the animal host species geographic distribution, disease transmission dynamics and control of infectious diseases is increasingly based on mathematical or computational models (24, 25). The goals in model formulation and analysis include more fully understanding observed patterns, identifying the key determinants of this pattern, analysing how different interventions might be introduced at varying times after the emergence of an epidemic and determining what their influence would be on the future incidence of infection and associated disease (5, 9). With this aim in mind, it is essential to combine different sectors and disciplines (e.g. medical, veterinary, population biology, research, monitoring and reporting of wildlife health issues, information technology, economics, social science and diagnostics) (7). Satellite remote sensing of land surface conditions and atmospheric dynamics can provide important information that is relevant to the understanding of the coupling between climate variability, ecological dynamics and zoonotic disease outbreak patterns. Satellite remote sensing products from a variety of platforms can provide information on cloudiness, rainfall and temperature and vegetation conditions that are relevant to the emergence, spread and abundance of vectors that transmit various zoonotic diseases.

Advanced surveillance systems exist in a few countries (33) but most countries, especially developing countries, are ill equipped to develop, implement and maintain such systems. Emerging zoonotic diseases are likely to occur in countries that have the weakest infrastructures for detection and response. In the light of recent global events (e.g. the emergence of SARS and outbreaks of avian influenza) (10, 26), there is an urgent need to enhance the capacity of these countries and, subsequently, to connect the various surveillance and early warning, alert and response systems at regional and international levels.

New approaches to respond to emerging zoonoses outbreaks

A biphasic approach should be considered for the handling of emerging zoonoses: a short- to intermediate-term response to an outbreak or

emergency, indicated by an increasing number of cases (either veterinary or human), and a long-term comprehensive study of the ecology of the zoonotic pathogen (34). The short-term response should include setting up two emergency teams to respond rapidly to the disease outbreak or emergency. The first team should primarily be responsible for control of infection by creating a case definition, identifying the mechanism of disease transmission and breaking the chain of transmission, thus preventing new cases. The second team should concurrently undertake studies on disease ecology by compiling current knowledge on the disease and using this to develop and conduct preliminary animal surveys to identify the aetiological agent.

The two teams would be responsible for implementing short-term control measures and should determine whether or not there is a need for long-term follow-up studies by assessing the likelihood of recurrence or emergence in new areas.

There are a number of control methods and tools that are currently available at the animal reservoir, vector and human levels and that are appropriate for the prevention and control of emerging zoonotic diseases.

For domestic animals, the common methods and tools used in disease control are as follows:

- vaccination of pets or livestock (e.g. for rabies control)
- prophylactic use of antiparasitic treatment (e.g. anti-trypanosomals or coccidiostats)
- proper biosecurity and quarantine (e.g. separating wildlife from domestic stock, hygienic practices in husbandry and among farm workers)
- eradication programmes (depopulation)
- appropriate veterinary care
- proper herd health programmes.

Other such methods include:

- breeding for disease resistance
- feed and water control
- using best animal husbandry practices
- routine disease surveillance
- testing animals before entering or leaving a farm.

Disease surveillance and control in wild animals should take into consideration a number of conservation issues, particularly the conservation status of the species under investigation. The following methods and tools may be undertaken after careful evaluation of the species involved and its ecology:

- isolating and creating physical barriers to separate wild animals from farms or human dwellings
- animal population management complying with current animal welfare and/or animal conservation principles for non-livestock species
- treating and vaccinating defined populations (e.g. oral rabies vaccination of foxes)
- limiting wildlife movements
- conducting preliminary testing of all live imports and exports
- exercising care in adopting and translocating wild animals.

Vector control is an effective tool in the prevention and control of vector-borne zoonotic diseases. For example by, spraying against fleas and mosquitoes during plague and Rift Valley fever outbreaks, respectively, and using tick control in outbreaks of Crimean Congo haemorrhagic fever and Lyme disease. Other effective methods include environmental management through elimination of vector breeding habitats as well as limiting anthropogenic activities that promote vector breeding, such as land-clearing, unplanned development and the destruction of habitats that support vector predators.

Strengthening national, regional and international capacities for zoonoses surveillance, prevention and control

As the emergence of a disease in a given place on the planet may ultimately have consequences for all people, resource-rich countries should invest in the establishment and strengthening of surveillance systems in resource-limited countries as an acknowledge-

ment of the international significance of emerging zoonoses. Providing further support to international networks, especially those with a strong national capacity component and those with a zoonoses focus, would be a first step in that direction. Increasing direct support to countries should also be a priority.

The following recommended activities could facilitate the much needed international and national capacity strengthening for zoonoses surveillance, prevention and control/ elimination (34):

a) International organisations (WHO, FAO and OIE) should:

- Promote the value of surveillance to member countries. Much knowledge and information relevant to the detection of emerging zoonotic events of public health significance already exists in many countries. Countries should establish systems to obtain, collate and analyse relevant data centrally. The system should incorporate information from most qualified/appropriate people in the field.
- Ensure full implementation of the joint GLEWS agreement signed between the WHO/FAO/OIE to enable the detection of potentially linked animal and public health events.
- Encourage research to investigate the usefulness of surveillance data from novel systems (e.g. vector population monitoring, meteorological data, land surface scanning and animal and human demographics) for advanced warning of zoonotic public health events. Where applicable, such systems should be implemented at the national level, for example, early warning systems for Rift Valley fever, based on climatic data.
- Maximise opportunities for the rapid transfer of research on novel surveillance systems to their integration into surveillance and early warning and response systems.
- Provide a framework to gather data and information products from satellite remote sensing platforms to adapt their tools and analyses to near real-time monitoring of conditions associated with zoonotic disease outbreaks as a contribution to global public health surveillance systems.
- Encourage research on new approaches to transport laboratory specimens, based on transporting inactivated samples containing DNA and RNA, and on the handling of pathogens. Research should be conducted to analyse the biodiversity of potential pathogens in animal populations to support the upstream detection of agents of potential zoonotic significance.
- Encourage the development and use of inexpensive, sensitive and specific rapid diagnostic tests for field situations.
- Create and encourage political awareness of and support for the implementation of a public and animal health infrastructure to address zoonotic disease issues (13, 15).

b) Countries should:

- establish sustained personnel interchanges between ministries of agriculture and ministries of health. If veterinary and public health personnel become familiar with each other before a crisis, they will be in a better position to resolve inevitable differences that arise during an animal or human health emergency (31).
- Better integrate animal and human health services at the national level. This may require cultural shifts within agencies and the development of new systems and capacities. In each country, there should be an intersectoral committee for zoonoses preparedness and control. Such committees should include representatives of relevant public and animal health agencies and national reference laboratories. Countries should include non-traditional partners, such as non-governmental organisations (e.g. wildlife organisations) and zoos, in their networks to detect and respond to emerging zoonotic infections (6, 8).
- Implement systems for the identification and localisation of commercial animal herds/flocks and for tracking national and international livestock movements.
- Conduct an assessment of the possible negative impact on the environment and endemic wildlife species (7) and ultimately public health of national projects that promote mixed animal farming or large-scale, single-species animal production

systems, or that promote a change in policy (e.g. introduction of a vaccination programme). This assessment should include the potential to manage the risk of new zoonotic agents. Changes in known or potential risk factors for emergence of zoonotic disease should be monitored.

- Incorporate the modelling and prediction of potential spread in national preparedness plans for an outbreak response once an unusual disease event is detected.
- Conduct cost-benefit assessments, including animal health and productivity data as well as public health costs, to demonstrate to countries the benefits of surveillance to prevent and control zoonotic disease.

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