Public health implications of emerging zoonoses

F.-X. Meslin (1), K. Stöhr (2) & D. Heymann (3)

(1) Coordinator, Animal and Food-Related Public Health Risks, Department of Communicable Disease Surveillance and Response, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland
(2) Scientist, Animal and Food-Related Public Health Risks, Department of Communicable Disease Surveillance and Response, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland
(3) Executive Director, Communicable Diseases Programme, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland

Summary

Many new, emerging and re-emerging diseases of humans are caused by pathogens which originate from animals or products of animal origin. A wide variety of animal species, both domestic and wild, 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. The authors describe the 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 two groups of people, namely: health professionals and the general public. Professional assessment of the importance of these diseases influences public health practices and structures, the identification of themes for research and allocation of resources at both national and international levels. The perception of the general public regarding the risks involved considerably influences policy-making in the health field. Extensive outbreaks of zoonotic disease are not uncommon, especially as the disease is often not recognised as zoonotic at the outset and may spread undetected for some time. However, in many instances, the direct impact on health of these new, emerging or re-emerging zoonoses has been small compared to that of other infectious diseases affecting humans.

To illustrate the tremendous indirect impact of emerging zoonotic diseases on public health policy and structures and on public perception of health risks, the authors provide a number of examples, including that of the Ebola virus, avian influenza, monkeypox and bovine spongiform encephalopathy. Recent epidemics of these diseases have served as a reminder of the existence of infectious diseases and of the capacity of these diseases to occur unexpectedly in new locations and animal species. The need for greater international co-operation, better local, regional and global networks for communicable disease surveillance and pandemic planning is also illustrated by these examples. These diseases have contributed to the definition of new paradigms, especially relating to food safety policies and more generally to the protection of public health. Finally, the examples described emphasise the importance of intersectorial collaboration for disease containment, and of independence of sectorial interests and transparency when managing certain health risks.

Keywords
Introduction

Many of the human diseases that are new, emerging and re-emerging at the close of the 20th Century are caused by pathogens which originate in animals or products of animal origin. In addition, a number of well-known zoonotic diseases, such as rabies, brucellosis, leishmaniosis and echinococcosis continue to affect human and animal populations in many countries, especially in the developing world. A wide variety of animal species, both domestic and wild, act as reservoirs for these pathogens, which may be viruses, bacteria or parasites. Given the wide range of animal species involved and the usually complex natural history of the pathogens concerned, the effective surveillance, prevention and control of zoonotic diseases pose a significant challenge to public health.

In this paper, the authors consider the direct and indirect implications for public health of new, emerging zoonoses. Direct implications are defined as the consequences on human health expressed in terms of morbidity and mortality. Indirect implications are defined as the repercussions of the influence of new, emerging zoonotic diseases on two groups of people, namely: health professionals and the general public. Professional assessment of the importance of these diseases influences public health practices and structures, identification of themes for health research and allocation of health resources at national and international levels. The perception of the general public regarding the risks involved contributes considerably to the shaping of public health policy.

Costs and losses stemming from the occurrence of these new diseases have in some cases been enormous, whether for the health sector, the national economy of the affected country, or the international community. For example, the United Kingdom (UK) has spent over £3 billion to control the bovine spongiform encephalopathy (BSE) epidemic, yet cases continue to occur. The damage to the cattle industry in all countries affected with BSE is immense, and the cost to cattle producers has been devastating. The social and economic repercussions of the Nipah virus outbreak in Malaysia have been very great, involving as it did the culling of over one million pigs as part of the outbreak response, and significant movement of human populations in the affected areas. In addition, the outbreak will have far-ranging consequences on the pig industry and the workforce involved in the livestock industry in the region. Among these social and economic issues, the impact of redirecting resources in emergency situations when overall budgets are limited, is an important additional indirect implication of these diseases.

Morbidity and mortality of new, emerging zoonotic diseases

Large outbreaks: the tip of the iceberg

Zoonotic diseases can rapidly cause extensive human suffering and death. For example, Rift Valley fever (RVF), a mosquito-borne disease, caused 89,000 cases and 150 to 250 deaths during the outbreak in Kenya of 1997-1998. Diseases transmitted by food and water usually also affect large numbers of people; major outbreaks of such diseases which involved pathogens of animal origin have been reported in many countries during the 1990s. In 1993, in the United States of America (USA), hamburgers contaminated with Escherichia coli O157:H7 were served in at least 93 restaurants belonging to a fast-food chain, thereby placing large numbers of consumers at risk. Over 500 children and adults became ill and four children died (1). Also in 1993, an outbreak of cryptosporidiosis due to a contaminated municipal water supply in Milwaukee, Wisconsin, USA, caused diarrhoeal illness in approximately 403,000 people, 4,000 of whom required hospitalisation.

Invisible diseases

Other diseases may not be recognised as zoonotic at the outset. These diseases can spread undetected for many years, particularly if the incubation period is unusually long or the number of cases in both humans and animals is too small during the initial stages of transmission to suspect a link between the two diseases.

An example of the above is new variant Creutzfeldt-Jakob disease (nvCJD), caused by the BSE agent. The average incubation period is unknown but is likely to vary from ten to over twenty years. A total of fifty-two cases had been diagnosed by the end of December 1999 (49 in the UK, two in France and one in the Republic of Ireland). However, it is not yet known how many people were affected before appropriate control measures were taken. The number affected could be very few, but the possibility that several thousands of people have been affected cannot be ruled out. Assuming that BSE was transmitted to humans through the consumption of food of bovine origin containing brain tissues, a large number of people in the UK were at risk of exposure to the BSE agent during the early years of the epidemic. In addition, cattle and bovine products, including food for human consumption and animal feed containing bovine tissues (meat-and-bone meal) were exported from BSE-infected countries to many other countries until bans were enforced. Therefore, the globalisation of trade, in addition to animal feeding practices, may have increased the risk of exposure to the BSE agent of human and animal populations besides those living in the infected countries of western Europe.
were reported from 1989 to 1997 contributed greatly to Ebola focus is rather limited, provided that essential control indicate that prolonged disease propagation from an initial these scenarios have materialised. The evidence seems to attention on the disease and feeding fears that the disease also been discussed and have contributed largely to increasing The threat of communicable disease also introduced to other continents, via international flights, have also been discussed and have contributed largely to increasing attention on the disease and feeding fears that the disease might become a major threat world-wide. However, neither of these scenarios have materialised. The evidence seems to indicate that prolonged disease propagation from an initial Ebola focus is rather limited, provided that essential control measures are in place. The series of filovirus outbreaks which were reported from 1989 to 1997 contributed greatly to promoting the concept of emerging communicable diseases among public health officials, stressing the renewed importance of microbes and denouncing the existing complacency regarding the importance of surveillance, prevention and control of communicable disease in the rapidly changing world. These outbreaks also gave further support to the opinion of the general public and health professionals that the emergence of a new killer disease in a very remote area of the world represents a threat for all humans, thereby reinforcing the sense of belonging to the same world (14, 19, 20).

Zoonoses versus major killer diseases

In many instances, the direct impact on health of these new, emerging or re-emerging zoonoses has been small compared to that of many other infectious diseases. The annual cumulative number of deaths due to major infectious and parasitic diseases is estimated at approximately 13.3 million in children and young adults (one in two deaths in developing countries). Six diseases cause 90% of these deaths, namely: acute respiratory infections including pneumonia and influenza (3.5 million), acquired immune deficiency syndrome (AIDS) (2.3 million), diarrhoeal diseases (2.2 million), tuberculosis (1.5 million), malaria (1.1 million) and measles (0.9 million) (22). Rabies, the leading cause of death in the zoonotic disease group, accounts for between 40,000 and 60,000 deaths per year. Yellow fever accounts for approximately 30,000 deaths and Japanese encephalitis 10,000 (13). In contrast, the total number of cases infected by the Ebola virus, since the first outbreaks were identified in 1976, does not exceed 1,000, although more than 700 of these cases eventually died of the disease (8, 16). Less than 1,000 cases of monkeypox have been reported since monkeypoxvirus was recognised as a cause of human illness in 1970. Approximately 400 cases were reported during the period from 1970 to 1992 and the remaining 500 cases occurred more recently and over a much shorter period of time, in an apparently still ongoing outbreak which was first detected in February 1996, in the Kasai Oriental Province of the Democratic Republic of the Congo (DRC) (23).

Influences on public health practices and structures

The threat of communicable disease

The possibility that the Ebola agent could spread beyond rural areas to infect the populations of larger cities, so triggering a major outbreak in the affected countries has been seriously considered. Furthermore, the risks of the disease being introduced to other continents, via international flights, have also been discussed and have contributed largely to increasing attention on the disease and feeding fears that the disease might become a major threat world-wide. However, neither of these scenarios have materialised. The evidence seems to indicate that prolonged disease propagation from an initial Ebola focus is rather limited, provided that essential control measures are in place. The series of filovirus outbreaks which were reported from 1989 to 1997 contributed greatly to

Pandemic planning

The outbreak of H5N1 avian influenza in Hong Kong in 1997 and 1998 affected only eighteen people, with six very unfortunate deaths, some in very young infants. Once again, the possibility that this outbreak may have heralded a pandemic of influenza was intensively discussed. This pandemic did not materialise as the avian virus did not transmit easily between humans. However, this was the first demonstrated evidence of an avian virus crossing the human species barrier, causing infection and death. The influenza pandemic known as 'Spanish flu', which killed twenty million people world-wide between 1918 and 1920 was also thought to be due to a virus which originated from an animal reservoir (swine). This underlines the global significance of the outbreak in Hong Kong and the need to adjust plans for global management and containment of a future pandemic. The outbreak highlighted the importance of surveillance of influenza viruses of animals, particularly wild and domestic birds, as well as pigs, and the need to reinforce the veterinary component of the global influenza surveillance network co-ordinated by the World Health Organization (WHO), particularly in countries of the Far East (16, 21).

Global alert and response

During the first phases of the investigation of the monkeypox outbreak of 1996 in the DRC, increased secondary attack rates were reported, suggesting that the self-limited transmission characteristic of the disease had altered. This led to various hypotheses regarding the possible causes. Some raised the possibility that the disease may represent the return of another form of smallpox (4). However, complete data analysis has revealed no evidence of increased transmissibility (the household secondary attack rate [SAR] and the virus were similar to historical findings) and human immunodeficiency virus (HIV) was not a significant co-factor. Whether an epizootic of monkeypox was occurring in reservoir species in contact with humans is unclear. However, the increased incidence in the human population could be due to declining population immunity since the cessation of smallpox vaccination in the DRC in 1982. Despite the increased incidence of monkeypox, the reintroduction of smallpox vaccination was not thought appropriate, partially due to concerns about adverse events in a population with a potentially increasing HIV seroprevalence.
An impartial review of the results of the investigations required an international assessment by the WHO technical advisory group on human monkeypox. The issue of monkeypox attracted attention in relation to the decision of the World Health Assembly, in May 1999, to further postpone the destruction of the known stocks of live variola virus. One of the reasons for this decision was the need to develop a better vaccine against smallpox and other orthopoxviruses to deal with occurrences such as the monkeypox outbreak (4, 14, 19, 20, 21, 23, 24, 25, 26).

**Uncertain risks and the precautionary principle: the bovine spongiform encephalopathy crisis**

The BSE/nvCJD outbreak represents one of the major health crises that governments have had to face over the past twenty years. An important reason for this may have been that scientists could not exclude a risk to human health from the outset, nor could they quantify precisely the risk for human health when the problem occurred. As a consequence, health officers and decision-makers were uneasy at having to respond objectively and in the best public interest (both to public demand and to the concerns of the professionals in the industry), in a situation where science does not provide a firm basis to prevent a decision being challenged (9).

The present health implications of BSE are manifold. Many countries have made major changes to feeding methods for food animals and to slaughterhouse practices. The epidemic of BSE illustrated the importance of preventing contamination at the earliest point in the food chain and the unpredictable consequences for the rest of the food chain of compromising safety at the early stage (6). The BSE crisis has contributed to a great extent to the introduction of major changes in arrangements for handling food safety issues at the European Union level and in countries such as the UK and France (2, 5, 10). In these countries, the changes aim to create an agency independent of sectoral interests, with a clear focus to protect public health. The crisis has also precipitated the application of risk assessment methodologies to microbiological risks in food safety. More unexpectedly, the epidemic of BSE has also led to a questioning of the safety of using animal tissues for the production of human biologicals and medical devices. Finally, the emergence of nvCJD has had even further distant ramifications in the health field, leading some countries to alter the existing policies for blood donations and sourcing of blood and derivatives (15).

The BSE crisis has also contributed to a reassessment of decision-making in public health and the recognition that this is a complex process guided by a number of rationales, namely: risk assessment, public perception, economic interests and social and cultural values. It was recognised that science, which was previously considered as the most important source of definitive answers, was merely part of the process, and often a minor component at that. The importance of increasing public awareness and involvement in all matters related to health has also been revealed, as much of the debate at all levels was fed by public perception, which was largely shaped by the media. The general public was greatly alarmed by life-threatening diseases which could be transmitted world-wide, for which no treatment existed, and which could be transmitted insidiously through common daily activities such as eating or drinking. Consumers also felt that the scientific community had little control and insufficient knowledge of these diseases.

Finally, the BSE/nvCJD crisis has led to the renewed application of an existing concept, so far under-utilised in the public health field, namely: the precautionary principle. The precautionary principle, first applied to the field of environmental safety, states that, in the face of uncertain risk and incomplete data, policy-makers should err on the side of restraint. The corollary of the principle states the primacy of health over all other considerations, especially economic.

**Intersectoral collaboration for the control of zoonoses**

In Malaysia, after the Nipah virus had been recognised as a new entity, control measures were implemented which included restrictions on the importation and movement of pigs, culling of pigs in affected areas, minimising contact between humans and potentially infected animals, wearing protective clothing and hygiene measures for humans in contact with pigs, and active surveillance for human cases. High-level government commitment was essential in enacting control measures. Co-ordination between veterinary and human public health services was reinforced and co-operation is now ongoing.

Although the outbreak has been controlled successfully, various problems were identified, including co-ordination between human and veterinary public health services and the other government departments involved, co-ordination of international inputs, and response to the media. The need for an effective intersectoral group dealing with zoonotic diseases is one of the lessons that has been learnt during the Nipah virus outbreak (27).

**Conclusion**

The occurrence of a significant number of outbreaks of new and emerging zoonotic diseases over the past few years is a matter of concern. Similar occurrences can be expected in the future as the continuous alteration of the environment and the establishment of human settlements in formerly uninhabited areas, particularly in the tropics, are factors that favour the emergence of diseases, the agents of which may have remained undiscovered in nature for centuries. To these problems are added the ever-increasing demand for animal protein foods, the acceleration of international trade, especially of food products and livestock, and the increasing number of people who are potentially more susceptible to
opportunistic infection by agents of animal origin. Apart from the direct impact on human health through sickness and death, these new, emerging zoonoses can have other important consequences, such as the following:

- to serve as a reminder of the existence of infectious diseases and the capacity of these diseases to occur very unexpectedly in new locations and new animal species
- to stress the need for stronger international co-operation, better local, regional and global networks for communicable disease surveillance and pandemic planning
- to contribute to the definition of new paradigms, especially relating to food safety policies and more generally to the protection of public health
- to reinforce the importance of intersectorial collaboration for disease containment in addition to that of independence of sectorial interests and transparency when managing certain health risks.

The challenge to public health posed by effective surveillance, prevention and control of zoonotic diseases can be met. The recent response to a number of outbreaks, for example, human monkeypox in central Africa, avian influenza in Hong Kong, RVF in Kenya and Somalia, and Nipah virus in Malaysia, has shown the types of partnership required.

The role of the WHO in this increasingly important area of public health is to strengthen the capacity of countries and the international community to prevent such dangers from developing, and to minimise the impact of outbreaks on public health. To achieve this, the WHO works in partnership with other organisations, within a global framework, to reshape and strengthen the network for communicable disease surveillance and control. The aim is to detect and contain the spread of viral, bacterial and zoonotic diseases where and when they occur.

Les zoonoses émergentes et leurs conséquences sur la santé publique

F.-X. Meslin, K. Stöhr & D. Heymann

Résumé

Nombre de maladies nouvelles, émergentes et réémergentes chez l'homme sont provoquées par des agents pathogènes transmis par des animaux ou des produits d'origine animale. De nombreuses espèces animales, domestiques et sauvages, servent de réservoir à ces agents, virus, bactéries ou parasites. Compte tenu de la diversité des espèces animales concernées, la surveillance et la prophylaxie efficaces des zoonoses constituent un véritable défi. Les auteurs décrivent les conséquences directes et indirectes des zoonoses émergentes sur la santé publique. Les conséquences directes sont celles qui se définissent en termes de morbidité et de mortalité. Les conséquences indirectes concernent l'incidence des maladies émergentes sur deux catégories de personnes : les professionnels de la santé et la population dans son ensemble. L'évaluation par les professionnels de l'importance de ces maladies détermine les pratiques et l'organisation en matière de santé publique, la définition de thèmes de recherche et l'affectation des ressources aux niveaux national et international. La façon dont l'opinion publique perçoit les risques influence aussi considérablement l'élaboration des politiques de santé. Des zoonoses épidémiques majeures peuvent survenir assez fréquemment, d'autant que dans la plupart des cas, le caractère zoonotique de la maladie n'est pas reconnu immédiatement et que l'épidémie peut se propager pendant quelque temps de manière inaperçue. Cependant, dans bien des cas, l'impact direct sur la santé publique de ces zoonoses nouvelles, émergentes ou réémergentes, est faible si on le compare à celui d'autres maladies infectieuses humaines.
Les auteurs illustrent de quelques exemples les effets indirects considérables des zoonoses émergentes sur les politiques et l'organisation de la santé publique et sur la perception par le public des risques sanitaires : ils évoquent notamment l'infection par le virus d'Ebola, la grippe aviaire, la variole du singe et l'encéphalopathie spongiforme bovine. Les épidémies récentes sont autant de rappels de l'existence de certaines maladies infectieuses et de leur capacité à apparaître dans des lieux inattendus ou d'atteindre des espèces animales inattendues. Ces exemples soulignent également la nécessité d'une coopération internationale plus large, de réseaux locaux, régionaux et mondiaux plus efficaces pour la surveillance des maladies transmissibles et d'une planification en cas de pandémie. Ces maladies ont contribué à la définition de nouveaux paradigmes, notamment en matière de politique d'innocuité alimentaire et, d'une manière plus générale, en matière de protection de la santé publique. Enfin, les exemples cités montrent l'importance d'une collaboration intersectorielle pour contrôler ces maladies, ainsi que de la transparence et indépendance des intérêts sectoriels qui doivent prévaloir au moment de gérer certains risques sanitaires.

Mots-clés

Consecuencias de las zoonosis emergentes en el campo de la salud pública

F.-X. Meslin, K. Stöhr & D. Heymann

Resumen
Muchas enfermedades nuevas, emergentes o reemergentes que afectan al ser humano son causadas por patógenos presentes en los animales o los productos de origen animal. Hay un gran abanico de especies animales, tanto domésticas como salvajes, susceptibles de ejercer de reservorio de dichos patógenos, que pueden ser virus, bacterias o parásitos. Dada la amplísima distribución de las especies animales afectadas, la aplicación de medidas eficaces de vigilancia, prevención y control de las enfermedades zoonóticas plantea grandes dificultades. Los autores describen las consecuencias directas e indirectas que tienen las zoonosis emergentes sobre la salud pública. Las primeras se definen como las repercusiones de una enfermedad sobre la salud humana en términos de morbilidad y mortalidad. Las consecuencias indirectas, por su parte, se definen como la influencia que ejerce determinada zoonosis emergente sobre dos categorías de personas: los profesionales de la salud y el gran público. Por un lado, la importancia que los profesionales de la salud otorguen a esas enfermedades condicionará tanto la práctica clínica y las estructuras sanitarias como la elección de temas prioritarios para la investigación y la asignación de recursos a escala nacional e internacional. Por otro lado, la idea que se forme la opinión pública de los riesgos asociados a una enfermedad incidirá notablemente en la definición de la política sanitaria. Los grandes brotes de enfermedades zoonóticas no son infrecuentes, considerando sobre todo que el principio no suele reconocerse la naturaleza zoonótica de la enfermedad y que ésta puede propagarse de forma inadvertida durante cierto tiempo. Sin embargo, las consecuencias directas de estas zoonosis nuevas, emergentes o reemergentes
han sido en muchos casos de pequeña magnitud comparadas con las de otras enfermedades infecciosas que afectan al hombre.

Para ilustrar los tremendos efectos indirectos que ciertas zoonosis emergentes ejercen sobre la política y las estructuras sanitarias y sobre la percepción pública de los riesgos sanitarios que conllevan, los autores ofrecen varios ejemplos: virus Ebola, influenza aviar, viruela símica y encefalopatía espongiforme bovina. Las recientes epidemias de estas enfermedades han servido para recordar la existencia de enfermedades infecciosas y su capacidad de manifestarse inesperadamente en nuevas zonas geográficas o nuevas especies animales. Estos ejemplos ponen también de relieve la necesidad de intensificar la cooperación internacional y perfeccionar las redes locales, regionales y mundiales de vigilancia de enfermedades transmisibles y la planificación en caso de pandemia. La aparición de estas enfermedades ha propiciado la definición de nuevos paradigmas relacionados sobre todo con las políticas de protección alimentaria y, de manera más general, con la salud pública. Los ejemplos descritos, por último, subrayan la importancia de la colaboración intersectorial a la hora de luchar contra una enfermedad, y la necesidad de gestionar ciertos riesgos sanitarios de forma transparente, velando sobre todo por que los intereses sectoriales no interfieran en el proceso decisorio.

**Palabras clave**


**References**


