

Essential veterinary education in emerging infections, modes of introduction of exotic animals, zoonotic diseases, bioterrorism, implications for human and animal health and disease manifestation

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Summary

A fundamental role of the veterinary profession is the protection of human health through wholesome food and control of diseases of animal origin, especially zoonoses. Therefore, training of veterinary students worldwide needs to face the new challenges posed by emerging infections, both from wildlife and domestic animals, as well as risks from bio/agroterrorism. New courses emphasising recognition, response, recovery and prevention must be developed to respond to natural or intentionally induced emerging diseases and zoonoses. Training programmes in applied epidemiology, zoonoses and foreign animal diseases are crucial for the development of a strong workforce to deal with microbial threats. Students should learn the reporting pathways for reportable diseases in their countries or states. Knowledge of the principles of ecology and ecosystems should be acquired during pre-veterinary studies. Elective classes on wildlife diseases, emphasising wildlife zoonotic diseases, should be offered during the veterinary curriculum, as well as a course on risk communication, since veterinarians are frequently in the position of having to convey complex information under adverse circumstances.

Keywords

Bioterrorism – Curriculum – Emerging zoonoses – Exotic companion animals – Veterinary education.

Introduction

The global economy has triggered a considerable increase in the traffic of goods, including animals, animal products and products of animal origin, across international borders within the last 50 years. Similarly, international travel of

humans and their companion animals, as well as the developing markets for exotic companion animals, and bushmeat consumption worldwide, are increasing the risk of disease emergence, mainly of zoonotic origin. A fundamental role of the veterinary profession since its first inception is the protection of human health through wholesome food (initially through meat inspection) and

the control of diseases of animal origin, especially those that can infect humans (zoonoses). Therefore, the training of veterinary students worldwide needs to face the new challenges posed by emerging infections, both from wildlife and domestic animals, as well as risks caused by the intentional use of infectious agents to injure people or destroy agricultural resources.

A world at risk

Emerging infections and zoonotic diseases

Emerging and re-emerging infectious diseases have received increasing attention over the last 30 years. An estimated 75% of emerging infectious diseases are zoonotic, mainly of viral origin (e.g. Nipah virus, Hendra virus and monkeypox virus), and likely to be carried by vectors, such as West Nile virus in the New World (6). The emergence or re-emergence of many zoonotic diseases emphasises the role that veterinarians can play in the surveillance, control and prevention of zoonoses, since their training in disease recognition and population medicine makes them well suited for early detection networks (11).

However, a recent survey indicated that most veterinarians in the United States of America (USA) are not aware of the use of appropriate personal protective equipment and do not engage in practices that may help to reduce zoonotic disease transmission (27). Veterinarians and animal handlers are at higher risk of being exposed to zoonotic agents than the general population, and are ten times as likely to be exposed to *Coxiella burnetii*, the agent of Q fever, as the general population (17).

Another recent survey of veterinarian involvement in zoonotic disease prevention practices showed that a high proportion of respondents, 280/362 (77%), agreed that it was very important for veterinarians to educate clients on zoonotic disease prevention, but only 43% (158/367) reported that they had initiated discussions about zoonotic diseases with clients on a daily basis, and only 57% (203/356) indicated that they had client educational materials on zoonotic diseases available in their practices (16). Almost a third of the respondents (112/360) indicated that there were no written infection control guidelines for staff members in their practice, and 28% (105/371) reported having been infected with a zoonotic disease in practice.

The provision of information and training on infection control practices and the establishment of written infection control policies could be effective means of improving infection control in veterinary practices (27). Methods to increase the involvement of veterinarians in zoonotic disease prevention include the following:

- discussing zoonotic diseases more frequently with clients, physicians and public health agencies
- encouraging individuals at higher risk of zoonotic diseases to discuss these issues
- having educational materials on zoonotic diseases available for clients
- improving infection control practices
- ensuring that continuing education courses on zoonotic diseases are regularly available (16).

Therefore, it is extremely important for veterinary students to be properly trained in such public health issues.

The exotic companion animal trade, bushmeat and open markets and infections

Globalisation has had a large impact on the worldwide animal trade (19). The huge worldwide movement of animals has increased the potential for the translocation of zoonotic diseases, which pose serious risks to human and animal health.

Almost 38 million live amphibians, birds, mammals and reptiles were legally imported into the USA from 163 countries between 2000 and 2004 (14, 19). In a single year (2005), there were more than 210 million animals imported into the USA for zoos, exhibitions, food, research, game ranches and companion animals. The imports included 203 million fish, 5.1 million amphibians, nearly 1.3 million reptiles, 259,000 birds and 87,991 mammals. Similarly, large numbers of exotic animals are imported into the European Union (EU), such as birds, reptiles and amphibians, as indicated in Table I (13).

The USA is the main destination for exotic and endangered wild animals. For most of these animals, there are no

Table I
Recorded imports of birds, reptiles and amphibians into the European Union between 2000 and 2005 (13)

Imported birds, reptiles and amphibians	Total no.
Imported birds	
Psittacidae	1,268,768
Passerines	3,258,691
Other birds	174,818
Imported reptiles and amphibians	
Tortoises	163,508
Lizards	1,176,203
Snakes	311,456
Amphibians	40,300

requirements for zoonotic disease screening either before or after arrival into the USA (19). The US government employs just 120 full-time inspectors to record and inspect arriving wildlife. Trafficking in rare and exotic wildlife is a global business, worth US\$ 10 to \$20 billion annually (13).

The 2003 outbreak of human monkeypox virus in the USA illustrates the public health risks associated with live animal importation, especially exotic companion animals. Monkeypox is a zoonotic disease endemic to Central and West Africa. African rodents are considered to be the natural host of the virus which, in humans, causes rashes similar to those of smallpox, fever, chills and headache (2, 15). Human infections during the 2003 outbreak resulted from contact with pet prairie dogs (*Cynomys* spp.) that contracted monkeypox from diseased African rodents imported for the commercial companion animal trade (1, 8, 12, 20). This shipment of mammals, imported from Ghana, contained more than six species and a total of 762 African rodents, some of which were confirmed to be infected with monkeypox (12). The monkeypox outbreak resulted in 72 human cases, with 37 of those cases being confirmed by laboratory (1). Most patients had direct or close contact with the infected prairie dogs, including 28 children at a daycare centre, and veterinary clinic staff who handled ill prairie dogs, which were being presented by their owners for treatment, before it was recognised that the animals were infected with monkeypox (21).

The importation of domestic companion animals is also on the rise in many parts of the world. In recent years, there has been an increase in the number of purebred puppies imported for sale to US buyers. Many of these puppies are arriving from rabies-endemic areas and are too young to be vaccinated for rabies, thus posing a risk of widespread exposure of the public to this disease, as well as a risk for the re-introduction of canine rabies strains into the USA. The Division of Global Migration and Quarantine, of the Centers for Disease Control and Prevention (CDC), estimates that as many as 300,000 puppies a year are being imported into the USA (18). The Border Puppy Task Force in California estimates that 10,000 puppies entered San Diego County from Mexico in just one year (9). Such practices can lead to the re-emergence of viral strains of canine rabies, from which the USA is now considered free.

In the spring of 2007, a puppy from India was imported into Seattle, Washington. Days later, at its destination in Alaska, the dog was diagnosed with rabies, according to the Washington Veterinary Board of Governors. In 2004, Los Angeles saw its first case of rabies in 30 years, with a puppy imported from Mexico. In Massachusetts, a dog imported from Puerto Rico – a USA territory where stray dogs are rampant – was diagnosed to be infected with a

rabies strain commonly detected in this part of the world. In 2008, rabies was diagnosed in a dog imported from Iraq, brought in among a shipment of 24 dogs and two cats as part of an international animal rescue operation (3). Additionally, 24 of these animals were distributed to 16 states. In Western Europe, cases of rabies in dogs, imported from areas where rabies is endemic, were reported from Belgium, Finland and France at the end of 2007 and in early 2008 (24). In France, a total of 22 imported cases of rabies were recorded for the period from 1968 to 2005, re-emphasising the risk of introducing rabies from endemic countries, mainly through illegal dog trafficking (23).

Wet markets and the demand for bushmeat in many parts of the world, especially in Southeast Asia and Africa, are a major source of emerging zoonoses. Unfortunately, this has been illustrated by outbreaks of Ebola virus in Western Africa and highly pathogenic avian influenza in Asia. In Africa, the bushmeat trade generates hundreds of millions of dollars. In the Congo Basin, trade and regional consumption of wild animal meat could reach 4.5 million tons annually. Moreover, the demand for bushmeat in Western and Central Africa could reach up to four times the demand for bushmeat in the Amazon Basin (1 million tons) (6).

Bioterrorism and zoonoses

As stated by Ryan (22), 'There is a long list of potential pathogens for use by terrorists, but only a few are easy to prepare and disperse. Of the infectious diseases, the vast majority are zoonoses.' As an example, 12 of 19 of the Category A, B and C bioterrorism agents, as catalogued by the CDC (4), are zoonotic in origin and are considered to be 'overlap high consequence agents and toxins' by the US Department of Agriculture (25).

In such situations, the use of animals as community sentinels appears to be an important surveillance tool for early detection of possible bioterrorism. The threat of bioterrorism and emerging infectious diseases has prompted various public health agencies to recommend enhanced surveillance activities to supplement existing surveillance plans. Animals are more sensitive to certain biological agents and their use as clinical sentinels, as a means of early detection, is warranted (11).

Furthermore, the concept of agroterrorism has also emerged, emphasising the major risk that the economy of a country could be massively disrupted by the introduction of highly contagious infectious disease outbreaks into the livestock or wildlife populations. As indicated by Crutchley *et al.* (7), 'The US agricultural infrastructure is one of the most productive and efficient food-producing

systems in the world. Many of the characteristics that contribute to its high productivity and efficiency also make this infrastructure extremely vulnerable to a terrorist attack by a biological weapon.'

Such risks also require proper training of veterinary students in foreign animal diseases and highly contagious livestock diseases. Unfortunately, in the USA, little attention has been given to such topics in the veterinary curriculum until recently.

Education requirements for undergraduate and graduate veterinary students

The number of hours dedicated to the subject of zoonotic diseases, especially new and emerging zoonoses, must be expanded to answer the major needs of society. This is crucial, since veterinarians may be among the first to recognise and identify these infections, as was the case with the introduction of West Nile virus into North America in 1999 (5). New courses emphasising recognition, response, recovery and prevention must be developed to respond to natural or intentionally induced new or emerging diseases and zoonoses. Training programmes in applied epidemiology are vital for the development of a strong microbial threat workforce. A basic epidemiology course, including outbreak investigation and disease surveillance, should be integrated into the curriculum of each veterinary school or college. This course should preferably be offered before the clinical component of the curriculum but after students have gained basic knowledge in the microbiology, immunology and pathology of infectious and zoonotic diseases.

Many health professionals, including physicians, rely on veterinarians and their knowledge of zoonoses. A survey of veterinarians and physicians on zoonotic diseases and at-risk patients showed that, compared with physicians and their patients, veterinarians appear more likely to discuss zoonotic diseases and the risks of companion animal ownership with their clients and are also more likely to gather information on zoonotic diseases to provide to their clients (26). A survey performed in Wisconsin, USA, asked physicians and veterinarians about the risk and prevention of zoonotic diseases in immunocompromised people (10). The survey found that physicians and veterinarians hold significantly different views about the risks posed by certain infectious agents and species of animals, and that the two groups communicate very little about zoonotic issues. Moreover, physicians believe that veterinarians should be involved in many aspects of zoonotic disease

prevention, including patient education. Therefore, basic training in epidemiology and zoonotic infections needs to be completed with an understanding of the main concepts of population medicine and disease control and eradication. An appropriate training in infectious and parasitic diseases, with, if possible, an emphasis on zoonotic diseases, should be part of every curriculum. It also seems necessary to integrate classes on foreign animal and zoonotic diseases into the required curriculum, especially those diseases that are major threats because of possible agroterrorism/bioterrorism or the spread of zoonoses.

Public health curricula for veterinary students should include some exposure to the regulations that govern the importation of animals, such as the federal regulations of the USA, particularly those concerning major zoonoses, such as avian influenza and rabies. Students should also understand which national and international agencies are responsible for regulations on companion animals, wildlife and livestock. They should be aware that regulations on zoonoses management and control may differ from country to country or from state to state.

Students should learn the reporting pathways for notifiable diseases in their own country, or the country or state in which they intend to seek licensing. In the USA, these could include the:

- state veterinarian
- state public health veterinarian
- wildlife control agency
- state epidemiologist.

They should be taught the importance of knowing which diseases are reportable in their own state or country, and take seriously the responsibilities associated with signing interstate or international health certificates for the movement of animals, to help prevent the translocation of zoonotic diseases.

It seems reasonable that knowledge of the principles of ecology and ecosystems be acquired either during pre-veterinary studies or at least at the beginning of the veterinary curriculum. Elective classes on wildlife diseases, with an emphasis on zoonotic diseases carried by various wildlife species, should be offered during the Doctor of Veterinary Medicine (DVM) curriculum. A course on risk communication would be very beneficial as veterinarians frequently have to convey complex information under adverse circumstances. Finally, students should be encouraged to seek out local, national and international training opportunities during their elective courses, to understand how all of this training can be integrated and used to the fullest in the field.

Conclusion

Veterinarians are broadly prepared and uniquely trained to meet the challenges of a changing world and their expertise is needed now more than ever. Whether they choose to stay in clinical practice or pursue a public health career, they are considered the 'front line': first responders to report emerging diseases in animal populations that

could forecast a wider threat to public and animal health. Every time veterinarians step into an examination room or barn to examine a patient, they are drawing upon the skills they acquired in veterinary school. It is the responsibility of all veterinary educators to ensure that future veterinary practitioners are well prepared to 'expect the unexpected'.



Les fondamentaux de l'enseignement vétérinaire sur les maladies émergentes, les modalités d'introduction des espèces animales exotiques, les zoonoses, le bioterrorisme, les conséquences pour la santé humaine et animale et les manifestations des maladies

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Résumé

L'une des fonctions essentielles de la profession vétérinaire consiste à protéger la santé humaine en garantissant l'innocuité des denrées alimentaires et en luttant contre les maladies d'origine animale, notamment les zoonoses. Aussi l'enseignement dispensé aux étudiants vétérinaires partout dans le monde doit-il répondre aux nouveaux défis liés aux maladies infectieuses émergentes affectant les animaux sauvages et domestiques, ainsi qu'aux risques associés à l'agro/bioterrorisme. De nouveaux programmes de formation doivent être proposés, abordant la détection, la réaction, la récupération et la prévention, afin de faire face aux maladies émergentes d'origine naturelle ou intentionnelle et aux zoonoses. Ces programmes doivent inclure des cours d'épidémiologie appliquée ainsi qu'une formation sur les zoonoses et les maladies animales exotiques afin de développer les compétences professionnelles nécessaires pour traiter les menaces microbiennes. Les étudiants doivent connaître les procédures de déclaration des maladies applicables au niveau national. Des connaissances de base sur l'écologie et les écosystèmes devraient avoir été acquises au préalable. Les programmes d'enseignement vétérinaire doivent proposer des cours optionnels sur les maladies de la faune sauvage, notamment sur celles à caractère zoonotique, ainsi qu'un cours sur la communication en matière de risques, car les vétérinaires se trouvent souvent en position de devoir fournir des informations complexes dans des situations difficiles.

Mots-clés

Animal de compagnie exotique – Bioterrorisme – Enseignement vétérinaire – Zoonose émergente.



Enseñanza veterinaria básica sobre infecciones emergentes, modos de introducción de animales exóticos, enfermedades zoonóticas, bioterrorismo, consecuencias para la salud humana y animal y manifestación de enfermedades

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Resumen

Una de las funciones primordiales de la profesión veterinaria estriba en proteger la salud humana velando por la salubridad de los alimentos y controlando las enfermedades de origen animal, especialmente las zoonosis. De ahí que en la formación de los futuros veterinarios convenga abordar los nuevos problemas que plantean las infecciones emergentes de la fauna tanto salvaje como doméstica, así como los riesgos ligados al bio/agro-terrorismo. Para responder debidamente a enfermedades y zoonosis emergentes, ya sean de origen natural o inducidas por el hombre, es preciso definir nuevas materias en las que se haga hincapié en la detección, la respuesta, la recuperación y la prevención. Los programas de formación en epidemiología aplicada, zoonosis y enfermedades animales exóticas son fundamentales para disponer de personal competente a la hora de afrontar amenazas microbianas. Los estudiantes deben aprender los cauces existentes para notificar enfermedades de declaración obligatoria en su país o estado. Al llegar a los estudios de veterinaria el alumno debe conocer ya los principios de la ecología y los ecosistemas. En los planes de estudios de veterinaria deben ofrecerse cursos optativos sobre enfermedades de la fauna salvaje, en los que se insista sobre todo en las de carácter zoonótico, así como una asignatura sobre comunicación del riesgo, pues los veterinarios se encuentran a menudo en la tesitura de tener que comunicar información compleja en circunstancias adversas.

Palabras clave

Animal de compañía exótico – Bioterrorismo – Enseñanza de la veterinaria – Zoonosis emergente.



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