Zoonoses

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Humans and their domesticated dogs and cats have lived in close proximity to one another for millennia. This long period of cohabitation seems to have guaranteed that, with some notable exceptions, the most important thing transmitted among them is affection. This is not so for our contact with other members of the animal kingdom. The past two decades have seen the emergence of at least a half-dozen newly recognized zoonotic infections, some of which have the potential to cause devastating pandemics.

Dozens of infectious diseases can be classified as zoonoses on the basis that the natural reservoirs from which the disease is transmitted to humans are animals, reptiles, or birds. Zoonoses can be further parsed into those that are transmitted directly from animals through intimate contact or a bite, those transmitted by the ingestion of water or the breathing of air contaminated by the excreta of animals or birds, and those that require an insect vector for transmission.

Examples of directly transmitted zoonoses include rabies, psittacosis/ornithosis, tularemia, Q fever, lymphocytic choriomeningitis, hantavirus infection, and—most recently described—monkeypox and avian influenza. Severe acute respiratory syndrome (SARS) appears to have started as a direct zoonotic infection through exposure to civets. However, once a person is infected with SARS, the virus is transmitted primarily by person-to-person spread.

Contamination-related zoonoses include giardiasis (most often contracted through ingestion of water containing beaver excreta), childhood *Salmonella* infection transmitted through water contaminated with excreta from pet reptiles, and leptospirosis caused by exposure to rodent urine. Also in this group is cryptococcal infection contracted through the inhalation of dried pigeon excreta.

Vector-borne zoonoses are usually transmitted by the bite of a specific mosquito, tick, or other arthropod. Diseases in this group include West Nile virus (WNV) infection, Lyme disease, Rocky Mountain spotted fever, rickettsial pox, babesiosis, ehrlichiosis, and the arbovirus infections, including the equine encephalitides.

Therefore, how do we characterize bovine spongiform encephalitis (mad cow disease)? If one confers infectious disease status to this prion-associated illness, then it is certainly a zoonosis that can be classified as “contamination-related.”

In attempting to diagnose a cryptic infection, two of the infectious disease specialist’s favorite questions have—for good reason—involved history of exposure to animals and recent travel. However, there are immensely important new lessons to be learned from some of the more recently identified zoonoses in the United States. Only approximately 3 years ago, WNV encephalitis was first identified in the Northeast region of the United States. As the name implies, this entity had been previously endemic in the Nile delta of Africa, with some cases described in the Middle East, Asia, and Europe. The identification of the disease in the United States initially engendered fears of purposeful dissemination by bioterrorists, but it is more likely that an infected bird or a mosquito vector was inadvertently imported to this country. The most common host bird in the United States has been the crow, and the finding of dead crows is used as a sentinel event for the presence of WNV in the region. In the course of only 3 years, WNV has spread throughout the East, Southeast, and Southwest regions of the United States. The lessons from this phenomenon are that rapid worldwide travel, the migration of birds, or both can yield an ever-changing and expanding “endemic area” for diseases for which birds are the natural reservoir. Once WNV has established itself in a new geographic area, seasonal recurrences of WNV encephalitis will doubtless continue, demonstrating that one need not go to exotic places to acquire heretofore exotic infections.

A second instructive zoonotic outbreak is the SARS epidemic of 2003, which was caused by a member of the coronavirus family (SARS-CoV). The epidemic began in Asia and was imported to North America. The original source is thought to have been direct contact with civet cats in China. Presumably, the virus had been indigenous to these animals for a long time, but close contact with humans and some adaptive changes of the virus resulted in human infection. Apparently, this virus is not generally as easily communicable as influenza, but through some “super spreader” infected humans, it was transmissible enough to cause hundreds of cases (many in hospitals that lacked proper infection control procedures) and had a case fatality rate perhaps three times that of influenza. The social and economic effects on the regions affected were

devastating and continue to this day. The key lessons from this outbreak are the virus' apparent ability to adapt for human-to-human transmission in one step and the need for public health agencies to identify (admit to) and take the necessary infection control measures to limit spread.

The recent outbreaks of avian influenza must be considered with some degree of "shock and awe." The first of these outbreaks occurred in Hong Kong in 1997 and involved an H5N1 strain of influenza virus. Although only a score of victims were identified, the disease had a high case fatality rate. Through excellent public health initiatives, the source was traced to infected poultry, and by dint of rapid mass slaughter of poultry, the outbreak was rapidly controlled. Other outbreaks of avian influenza were identified in the Netherlands several years later, and 2004 has seen outbreaks among poultry that have involved large areas of Asia. Again, the case fatality rate has been high, but through vigilance, culling of birds, and quarantine of poultry shipments, the disease in humans has been limited. One of the prime factors in the ability to limit spread has been the lack, thus far, of human-to-human transmission.

Classically, influenza has not been considered a zoonosis because most spread is human-to-human. Birds were thought to play a role in maintaining influenza virus from season to season, and swine were seen as a vehicle or vessel for the possible reassortment or recombination of influenza virus genetic material through coinfection of pigs by two strains, both coming from humans, or

one directly from humans and another perhaps from birds, yielding a recombinant agent. This "antigenic shift" hypothesis is supported by the fact that most influenza epidemics and pandemics seem to originate in the farming areas of China, and the farming practices there were seen to promote these interactions by the intimate living conditions of water fowl, swine, and humans. The year 1997 marked the first evidence that avian virus, lethal to humans, had been passed directly to humans. One can only await with trepidation the (inevitable) adaptation of avian virus to human-to-human passage.

Our progress in eradicating nonzoonotic diseases has been considerable. Naturally occurring smallpox has been eliminated, and we may realistically hope for the complete elimination of poliomyelitis and measles. What then, are the prospects for dealing effectively with old and new zoonoses? Additional safeguards against importation of infected animals, appropriate arthropod control, limiting exposure to animal excreta, and the creation of sentinel veterinary hospitals and diagnostic laboratories will provide some increased protection. However, although animal and vector control, and the development and administration of effective vaccines, can reduce the incidence of many infections, the potential to eliminate a given disease from the face of the earth ultimately depends on the absence of nonhuman reservoirs of infection. Therefore, new zoonoses will certainly continue to emerge, and this problem, in one form or another, will plague us for as long as humans and animals both inhabit the earth.