Zoonotic Diseases:
An Emerging Global Health Challenge

Although noncommunicable diseases are the leading cause of morbidity and mortality in most developed nations, infectious diseases, particularly those transmitted through contact with animals, remain a major public health concern.

By Trudie Mitschang

In the early 1960s, vaccines for viral diseases such as measles, mumps, rubella and polio promised to control and potentially eradicate these and other highly contagious infections. Even smallpox, a disease caused by the variola virus that was responsible for the deaths of between 300 million and 500 million people during the 20th century, showed signs of succumbing to an intense global immunization campaign. In the wake of such promising advances, Australian virologist and Nobel Prize winner Macfarlane Burnet made the following statement: "There may be some wholly unexpected emergence of a new and dangerous infectious disease, but nothing of the sort that has marked the past fifty years."[1]

Unfortunately, that prediction has proven to be only partly true, as evidenced by a host of new, unexpected infectious diseases, including a plethora of zoonotic diseases and epidemics that could offer only a glimpse of potential deadly pandemics to come. The emergence of the MERS virus in Saudi Arabia, a new killer strain of bird flu in China and an unprecedented Ebola outbreak in West Africa have all highlighted the scientific community's failure to pinpoint the source or identify the means to stop the impending wave of viral threats.

"Research in all of the epidemics we have faced over the past decade has been woeful," said Jeremy Farrar, director of the Wellcome Trust global health foundation and an expert on infectious diseases.[2] "The world is at risk because there are huge gaps in our knowledge base. We don't now have a vaccine for SARS if it came back tomorrow; we don't know how to treat MERS; it took us six to nine months before we started clinical trials of vaccines for Ebola and in the meantime almost 12,000 people lost their lives; and during the H1N1 pandemic, the number of people randomized into clinical studies was very close to zero."

An Escalating Concern

Over the last 15 years, the world has witnessed more than 15 deadly zoonotic or vector-borne global outbreaks, and since 1980, more than 87 new zoonotic and/or vector-borne diseases have been discovered. Some estimates state that approximately 75 percent of newly emerging infectious diseases are zoonoses.[3]

By definition, any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa is classified as a zoonosis. According to the Pan American Health Organization publication *Zoonoses and Communicable Diseases Common to Man and Animals*, zoonoses have been recognized for many centuries, and over 200 have been described. They are caused by all types of pathogenic agents, including bacteria, parasites, fungi and viruses.[4]

Reducing public health risks from zoonoses and other health threats at the human-animal-ecosystems interface is a complex challenge at best, says the World Health Organization (WHO). Management and reduction risks must take into account the myriad interactions among humans, animals and the various environments they live in, and any long-range plan will require communication and collaboration among all the sectors responsible for human health, animal health and the environment. In other words, multiple stakeholders must commit to making the identification and eradication of zoonotic diseases a top priority.

WHO is engaging in an ever-increasing number of cross-sectoral activities to address many of these health threats, including existing and emerging zoonoses[4] in four major categories:

• *Bacterial threats.* Every year, millions of people get sick because of foodborne zoonoses such as Salmonellosis and Campylobacteriosis. These types of illnesses can cause fever, diarrhea, abdominal pain, malaise and nausea. Other bacterial zoonoses include anthrax, brucellosis, infection by verotoxigenic Escherichia coli, leptospirosis, plague, Q fever, shigellosis and tularaemia.

• *Parasites.* In Latin America alone, 100 out of 100,000 inhabitants suffer from a parasite infection called cysticercosis/ taeniasis found in swine that is linked to seizures headache and many other symptoms. Other parasitic zoonoses include trematodosis, echinococcosis/hydatidosis, toxoplasmosis and trichinellosis.

• *Viruses.* Rabies is a well-known disease found in carnivores and bats that is mainly transmissible to humans by bites. An estimated 55,000 people, mainly children, die of rabies each year. Other viral zoonoses include avian influenza, Crimean-Congo hemorrhagic fever, Ebola and Rift Valley fever.

• *Fungi.* Dermatophytoses are superficial mycoses that may be acquired from infected animals and affect the skin, hair and nails of humans, causing itching, redness, scaling and hair loss. Another mycotic infection that can be zoonotic is sporotrichosis.

The Ebola Outbreak: What We Have Learned

The 2014 Ebola outbreak in West Africa dramatically raised awareness of the global burden of infectious diseases and raised questions about the preparedness of public health systems. It was documented as the worst outbreak of this virus in history. In Guinea, Sierra Leone and Liberia, the three countries most affected by the outbreak, about 70 percent of those infected have died.[5]

Although the research is ongoing, speculation regarding Ebola's origins has yet to produce a conclusive answer. The first known human cases of Ebola occurred in 1976 during two simultaneous outbreaks in Sudan and the Democratic Republic of the Congo, according to WHO.[6] Nearly 20 years later, in 2005, researchers looking for the reservoir of Ebola sampled more than 1,000 small animals in the Central African nations of Gabon and the Republic of the Congo, which experienced outbreaks of Ebola. They tested 679 bats, 222 birds and 129 small terrestrial vertebrates. The only animals found to harbor the Ebola virus were bats, and researchers have found Ebola virus RNA in at least three species of fruit bats. That made the animals — commonly hunted and eaten in Guinea — a top contender as the source of the disease.[7]

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In October 2014, panic ensued when a New York doctor returning from a humanitarian mission in West Africa tested positive for the Ebola virus. Later that year, two nurses from Dallas also tested positive for the virus. All three were quickly quarantined and have since recovered from the illness. Despite the hysteria driven by media coverage, public health officials believe the likelihood of a widespread Ebola outbreak in the U.S. is minimal. According to Dr. William Schaffner, a professor of preventive medicine and infectious diseases at Vanderbilt University Medical Center in Nashville, Tenn., if Ebola were to become widespread in the U.S., the mortality rate from the virus would likely be significantly lower than in Africa. "The death rate would be lower in the U.S.," said Schaffner in an interview with *Live Science*. "Everybody believes we could move it down from 50 percent to 30 percent, or perhaps even

lower than that. If they had available the kinds of supportive care that we're able to provide in the United States — in our hospitals and, particularly, in our intensive care units — the survival rate (in Africa) would be much higher."[8]

Ebola is not the only viral illness making headlines in recent years. In February, the public scrambled to understand the implications of the Zika virus after WHO designated it as an international public health emergency because of the suspected relationship between Zika and a rise in cases of a rare congenital condition called microcephaly in Brazil. Officials at the Centers for Disease Control and Prevention (CDC) have urged pregnant women against travel to about two dozen countries, mostly in the Caribbean and Latin America, where the outbreak is growing. Zika is a mosquito-transmitted infection related to dengue, yellow fever and West Nile virus. Although it was discovered in the Zika forest in Uganda in 1947 and is common in Africa and Asia, it did not begin spreading widely in the Western Hemisphere until May 2015.[9]

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Epidemic, Endemic or Pandemic: Understanding Key Terminology

Three terms are used in epidemiology — the study of the spread, causes and consequences of disease — to describe disease distribution:

• *Epidemic* is a widespread increase in the observed rates of disease in a given population. Diseases such as mumps, measles and cholera can become epidemics, depending on a range of factors.

• *Endemic* is a consistently heightened rate of disease observed in and associated with a given population over time. For example, malaria is endemic in a number of tropical zones in the world.

• *Pandemic* is a sudden increase in the observed rates of disease across many populations globally. The most infamous is the 1918-19 flu pandemic, which killed 675,000 people in the United States and millions around the globe.

It's important to note that the term "outbreak" can refer to an epidemic or pandemic. Epidemiologists' ability to define a disease distribution as epidemic, endemic or pandemic allows health workers, clinicians and policy makers to set local and global priorities for controlling illness and promoting health throughout a population level.

Defining and examining the global distribution of infectious diseases, in both time and location, is a major research priority. A 2014 study published in the *Journal of the Royal Society Interface* examines the global changes in the frequency of outbreaks of infectious diseases between 1980 and 2013. In all, the dataset covered 12,102 outbreaks of 215 diseases, with 44 million individual cases in 219 countries around the world. The researchers, based at Brown University, sought to examine the relationship between the location and timing of disease outbreaks and the characteristics of outbreak sites, such as the presence of certain animals that transmit disease to humans.[10]

Among the study's findings:

• Sixty-five percent of the diseases, making up 56 percent of all outbreaks, were zoonoses. These include Ebola, HIV, the bubonic plague and Lyme disease.

• Zoonotic diseases have been becoming increasingly diverse over time, but only a small number cause the majority of outbreaks in each decade: "From 1980 to 1990, 80 percent of all zoonotic disease outbreaks were caused by only 25 percent of potential zoonoses in the dataset, and only 22 percent and 21 percent of zoonoses from 1990 to 2000 and from 2000 to 2010, respectively." (The authors caution that zoonotic disease cases may be undercounted in the nations affected the most because of limited infrastructure and health resources.)

• Other factors influencing the rise of zoonotic diseases include the fact that human populations are growing and expanding into new geographic areas, and as a result, more people live in close contact with wild and domestic animals.

• Changes in climate and land use such as deforestation and intensive farming practices and disruptions in environmental conditions and habitats provide new opportunities for diseases to pass to animals.

• International travel and trade have increased, allowing diseases to spread more quickly than at any time in history.

Collaborative Solutions: The One Health Initiative

One Health Initiative is a term that refers to the concept of multidisciplinary collaborative approaches to solving today's global and environmental health challenges. The One Health Initiative autonomous pro bono team started the One Health Initiative website in 2008, which has since been serving as a global repository for all news and information pertaining to

One Health. Organizations supporting this movement include the American Medical Association, American Veterinary Medical Association, UC Davis One Health Institute, American Society of Tropical Medicine and Hygiene, American Association of Public Health Physicians, CDC, United States Department of Agriculture, National Oceanic and Atmospheric Administration and U.S. National Environmental Health Association. Additionally, more than 850 prominent scientists, physicians and veterinarians worldwide have endorsed the initiative.

One Health was born out of, and fueled by, fear. In 2004, there was global anxiety that a zoonotic disease, highly pathogenic avian influenza (HPAI) H5N1, could lead to a pandemic rivaling, and possibly exceeding, the catastrophic Spanish flu outbreak at the end of World War I. The introduction of the One Health Initiative provided international agencies with a vehicle for interinstitutional and interdisciplinary collaboration to address the threat of emerging zoonotic diseases like H5N1, and enabled these international agencies and national authorities to work together in the search for solutions.[11]

The global response to avian influenza was launched in January 2006 against a One Health backdrop at the International Ministerial and Pledging Conference of Beijing. This led to collaboration between the European Union, U.S. and the United Nations, and five subsequent years of cooperation focused on the control of avian influenza. In 2010, the World Bank published a framework for the control of animal influenzas through the application of One Health principles. The World Bank estimated that between 2005 and 2009, $4.3 billion U.S. were pledged for the international control of HPAI,[11] giving merit and credibility to the One Health concept.

With the success of that initial collaboration under its belt, the One Health Initiative is seeking to expand its efforts to "promote, improve and defend the health and well-being of all species by enhancing cooperation and collaboration between physicians, veterinarians, [and] other scientific health and environmental professionals."[12]

According to Dr. Laura Kahn, a physician on the research staff of the Woodrow Wilson School of Public and International Affairs at Princeton University, a One Health holistic approach to the challenges posed by 21st-century life and the resulting threat of zoonotic diseases is essential: "Climate change and increasing human populations will definitely increase the need for multidisciplinary, collaborative programs. As the Earth's resources are strained with increasing demands for energy, food, shelter and water, we must anticipate that a sustainable future will require a holistic approach to human, animal and ecosystem health. A One Health approach will be critical if we hope to meet the challenges of the 21st Century and beyond."[13] ❖

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