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War of the Worlds: Our Worlds are Colliding and Infectious Disease is Winning

Emerging Diseases and the One Health Initiative

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Abstract

Quoting the U.S. Surgeon General (1968), it is time to “close the book” on infectious diseases and shift public health resources to address chronic diseases. But our public health leaders can make mistakes. Around the time the Surgeon General was writing, there were scattered reports of a very interesting wasting disease among Africans that was noticed by missionaries. We now realize that these were the earliest cases of a newly emerging infectious disease: HIV/AIDS. Today, HIV/AIDS and other infectious diseases continue to pose a substantial threat throughout the world. Collectively, infectious diseases are the second leading cause of death globally, following cardiovascular disease, but among young people infections are overwhelmingly the leading cause of death. As we eradicate diseases such as polio and smallpox, something else emerges and takes their place. This is the nature of the perpetual challenge of infectious diseases. We now combat newly emerging diseases, 75 percent of which are associated with animals—zoonoses—and many are of our own creation. Multiple factors, including economic development and land use, human demographics and behavior, and international travel and commerce, contribute to the emergence and re-emergence of infectious diseases. Almost all of these factors reflect, in some measure, the encroachment of human civilization on the environment and on the microbial species that inhabit our environment. This has led to the new concept of a One Health Initiative, an all-inclusive collaboration among physicians, veterinarians, and other scientific-health related disciplines. The human species lives in a deli-

cate balance with microbial, animal and plant species; we should remember, however, that in this balance there is also an ever-present tension. Human beings have somehow separated themselves from the natural world in which we live. We have altered the physical, chemical, and biological systems and thus the balance. Our health depends on the health of other species and a healthy functioning ecosystem. That system is out of balance and we can run from the battles ahead or join the battle in this war of the worlds—the biological diversity, including infectious and emerging diseases

You are at a time in your life when you have the opportunity to ask questions, seek knowledge, and define the direction of your life. Here, I present you with a number of questions and facts. I hope to stimulate your interest and arouse your awareness of the world around you.

FACT: *Every 30 seconds a child dies of infectious disease.*

And we are only speaking of one disease agent. Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected mosquitoes. And yes, a child dies of malaria every 30 seconds from this disease. There were 247 million cases of malaria in 2006, causing nearly one million deaths, mostly among African children. But what is interesting is that malaria is preventable and curable. Approximately half of the world's population is at risk of malaria, particularly those living in lower-income countries. This is also where the greatest population growth is expected in the world. Travelers from malaria-free areas to disease “hot spots” are especially vulnerable to the disease. More importantly, malaria takes an eco-

conomic toll—cutting economic growth rates by as much as 2 percent in countries with high disease rates. Thus, the disease prevails, winning over the prosperity of a country and continent. The battle to control malaria is ongoing.

FACT: A disease was once regarded as vampirism. When one member of a family died from it, the other members that were infected would lose their health slowly.

According to the World Health Organization (WHO), nearly 2 billion people—one third of the world's population—have been exposed to the tuberculosis pathogen. Annually, 8 million people become ill with tuberculosis, and 2 million people die from the disease worldwide. In 2004, around 14.6 million people had active TB disease with 9 million new cases. The annual incidence rate varies from 356 per 100,000 in Africa to 41 per 100,000 in the Americas. Tuberculosis is the world's greatest infectious killer of women of reproductive age and the leading cause of death among people with HIV/AIDS.

The rise in HIV infections and the neglect of TB control programs have enabled a resurgence of tuberculosis. The emergence of drug-resistant strains has also contributed to this new epidemic. From 2000 to 2004, 20 percent of TB cases were resistant to standard treatments and 2 percent were resistant to second-line drugs. The rate at which new TB cases occur varies widely, even in neighboring countries, apparently because of differences in health care systems.

Before the Industrial Revolution, tuberculosis was sometimes regarded as vampirism. Tuberculosis is a communicable disease that would work its way through a family. Before we understood the disease, people believed that this was caused by the original victim draining the life from the other family members. Furthermore, people who had TB exhibited symptoms similar to what people considered to be vampire traits. People with TB often have symptoms such as red, swollen eyes (which also creates a sensitivity to bright light), pale skin, extremely low body heat, a weak heart and coughing blood, suggesting the idea that the only way for the afflicted to replenish this loss of blood was by sucking blood.

In a recent publication of *The New England Journal of Medicine*, authors documented the transmission of a multidrug-resistant *M. tuberculosis* infection during travel in an airplane. The World Health Organization and the Centers for Disease Control and Prevention (CDC) issued and published guidelines for the airline

industry to help minimize the risk of tuberculosis (TB) and other infectious diseases being passed from passenger to passenger on board aircraft.

FACT: Worldwide, one death in three is from an infectious or communicable disease.

However, almost all these deaths occur in the non-industrialized world. Health inequality affects not just how people live but often dictates how and at what age they die. Can we live with this? Where's our next disease coming from? The answer is that it could come from anywhere in the world—from overflowing sewage in Cairo, from a war zone in Iraq (*Acinetobacter baumannii* is a species of pathogenic bacteria that is naturally resistant to many antibiotics, and there have been many reports of *A. baumannii* infections among American soldiers wounded in Iraq), from an energy-efficient office building in California. Sick building syndrome (SBS) is a combination of ailments associated with an individual's place of work. The World Health Organization suggests up to 30 percent of new and remodeled buildings worldwide may be linked to symptoms of SBS (toxic mold microbes, chemicals, even lighting), from a poultry farm in China (Bird Flu) or Mexico (the Swine Flu). There is a pattern lying beneath the new diseases in the headlines (AIDS, Lyme) and the old ones resurgent (tuberculosis, cholera). As the human population explodes, ecologies collapse and simplify, and disease organisms move into the gaps. As globalization continues, diseases can move from one country to another as fast as an airplane can fly. As Laurie Garrett writes in *The Coming Plague: Newly Emerging Diseases in a World Out of Balance*, "while the human race battles itself... the advantage moves to the microbes' court. They are our predators and they will be victorious if we, *Homo sapiens*, do not learn how to live in a rational global village that affords the microbes few opportunities."

FACT: Infectious disease is on the rise. In 1978 a disease was noted to be transmitted by ticks. In 2009, those same ticks transmit multiple diseases and can transmit them all at the same time.

Lyme disease is the most common tick-borne disease in North America and Europe and one of the fastest-growing infectious diseases in the United States. Of cases reported to the United States CDC, the ratio of Lyme disease infection is 7.9 cases for every 100,000 persons. In the ten states where Lyme disease is most common, the average was 31.6 cases for every 100,000 persons for the year 2005. Although Lyme disease has been reported in 49 of 50 states in the U.S., about 99 per-

cent of all reported cases are confined to just five geographic areas and UNH is in the “hot-zone” of coastal New England. And, in your lifetime—the past two decades—ticks that transmit *B. burgorferi* to humans now carry and transmit several other parasites such as *Theileria microti* and *Anaplasma phagocytophilum*, which cause the diseases babesiosis and human granulocytic anaplasmosis (HGA), respectively. Among early Lyme disease patients, depending on their location, between 2 and 12 percent will also have HGA and between 2 and 40 percent will have babesiosis. The early clinical presentations of Lyme disease, HGA and babesiosis are indistinguishable from many common infectious and noninfectious disease; fever, headache, myalgia and malaise. So, with that next tick bite you may have not 1, not 2, but 3 infectious diseases with potential serious health consequences.

FACT: *Nearly 75% of emerging infectious diseases are zoonotic, transmissible between animals and man.*

In 1963, the respected physician and anthropologist T. Aidan Cockburn made the following statement in a book called *The Evolution and Eradication of Infectious Diseases*: “We can look forward with confidence to a considerable degree of freedom from infectious diseases at a time not too far in the future. Indeed...it seems reasonable to anticipate that within some measurable time...all the major infections will have disappeared.” Five years later, in 1968, the U.S. surgeon general noted that it might be possible with interventions such as antimicrobials and vaccines to “close the book” on infectious diseases and shift public health resources to chronic diseases. However as I mentioned at the outset, even public health leaders can make mistakes. AIDS was first reported June 5, 1981, when the U.S. Centers for Disease Control (CDC) recorded a cluster of other opportunistic diseases. In actuality it was in the U.S. for at least a decade. It took years to realize that there was a *newly emerging infectious disease*: HIV/AIDS. HIV/AIDS has changed the world and the views on infectious disease and the need to approach these new diseases with vigor and respect...a single virus and few gene mutations in a microbe can result in the death of millions.

Among the infectious diseases throughout the world there is the baseline matrix or pattern of infectious diseases that constitutes an ongoing threat. Then there are diseases that occur intermittently, some as little blips on the radar screen and some as major public health issues. At some point in time the matrix diseases have all been

emerging diseases. But after a while they become so entrenched and are considered part of the background matrix and not emerging or re-emerging diseases. So as we eradicate diseases such as polio and smallpox, something else emerges and takes their place. This is the nature of the perpetual challenge of infectious diseases.

What do I mean by a newly emerging disease? A *newly emerging disease* is a disease that has never been recognized before. HIV/AIDS is a newly emerging disease, as is severe acute respiratory syndrome (SARS), Nipah virus encephalitis, Ebola, Hanta virus, new strains of influenza, West Nile virus and variant Creutzfeld-Jakob disease (vCJD). Let’s take this latter disease as an example, vCJD. But, let’s twist it a little with reality in the fact below.

FACT: *The world population has doubled in the last 50 years. The population now exceeds 6 billion. The world population will again double in less than 50 years.*

We can’t seem to manage to provide healthy nutrition or even feed the 6 billion people that exist on this planet. How are we going to manage to feed 12 billion people? Keep in mind that we now turn 30 percent of our grains into biofuels. There is a food crisis. You would not know that visiting the local food market. The problem is not necessarily in your back yard but it certainly affects you. Consider variant Creutzfeld-Jakob disease (vCJD). How did this disease arise? The world needs protein and meat is a primary source. But, how do we raise this meat and how quickly can we do it? One answer has arisen: let’s feed cows to cows, sheep to cows, people to cows. Wait—feed people to cows? Alan Colchester, a professor of neurology at the University of Kent, writing with Nancy Colchester in the September 3, 2005 issue of the medical journal *The Lancet*, proposed a theory that the most likely initial origin of BSE in Britain was the importation from the Indian subcontinent of bone meal which contained CJD-infected human remains. Cattle are normally herbivores. In nature, cattle eat grass. In modern industrial cattle farming, various commercial feeds are used, which may contain ingredients including antibiotics, hormones, pesticides, fertilizers, and protein supplements. Maybe you should be a vegetarian and avoid all these factors surrounding meat. But, then tomatoes are engineered and are raised with pesticides, fertilizers, etc. How do we feed 12 billion people without science aiding in the sustainability of food production and safety? Food for thought!

We have many challenges ahead including the source of protein to feed the world and the challenges of our

healthcare system in the control of costs incurred by the aging population. Maybe the 1973 SciFi classic *Soylent Green*, after the book by Harry Harrison, is to be true. In the film, it's the year 2022. People will do anything to get what they need. And they need SOYLENT GREEN. The Plot: In an overpopulated futuristic Earth, a New York police detective (actor Charlton Heston) finds himself marked for murder by government agents when he gets too close to a bizarre state secret involving the origins of a revolutionary and needed new foodstuff. "SOYLENT GREEN IS PEOPLE..."

FACT: *More than 90 percent of all organisms that have ever lived on Earth are extinct.*

As new species evolve to fit ever changing ecological niches, older species fade away. But the rate of extinction is far from constant. At least a handful of times in the last 500 million years, 50 to more than 90 percent of all species on Earth have disappeared in a geological blink of the eye. Though these mass extinctions are deadly events, they open up the planet for new life forms to emerge. Those that evolve live on. Microbes evolve rapidly to new environments—even those full of antibiotics and pesticides. Humans are a bit slower in the evolutionary processes and thus are at risk to infectious diseases. Who will win out in this battle? We are not separate from the natural world in which we live.

To sustain life on this planet we need to maintain a balance with life. That is to say, human health depends on biodiversity. This is the foundation of the new health initiative, One World, One Health, One Medicine or, as it has evolved, the One Health Initiative. Representatives from the World Health Organization, the UN Food and Agriculture Organization, the Centers for Disease Control and Prevention, the United States Geological Survey National Wildlife Health Center, the United States Department of Agriculture, the Canadian Cooperative Wildlife Health Centre, the IUCN Commission on Environmental Law, and the Wildlife Conservation Society are among the long list of participants.

Phenomena such as species loss, habitat degradation, pollution, invasive alien species, and global climate change are fundamentally altering life on our planet, from terrestrial wilderness and ocean depths to the most densely populated cities. The rise of emerging and resurging infectious diseases threatens not only humans (and their food supplies and economies), but also the fauna and flora comprising the critically needed biodiversity that supports the living infrastructure of our world. The earnestness and effectiveness of humankind's environmental stewardship and our future health

have never been more clearly linked. To win the disease battles of the 21st Century while ensuring the biological integrity of the Earth for future generations requires interdisciplinary and cross-sectoral approaches to disease prevention, surveillance, monitoring, control and mitigation as well as to broad reaching environmental conservation.

It is clear that no one discipline or sector of society has enough knowledge and resources to prevent the emergence or resurgence of diseases in today's globalized world. No one nation can reverse the patterns of habitat loss and extinction that can and do undermine the health of people and animals. Only by breaking down the barriers among agencies, individuals, specialties, and sectors can we unleash the innovation and expertise needed to meet the many serious challenges to the health of people, domestic animals, and wildlife and to the integrity of ecosystems.

Take the lead!

Suggested Readings

The Coming Plague: Newly Emerging Diseases in a World Out of Balance, by Laurie Garrett

Sustaining Life: How Human Health Depends on Biodiversity, by Eric Chivian and Aaron Bernstein

Emerging Diseases of Animals, by Corrie Brown and Carole Bolin

Soylent Green, by Harry Harrison

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Emerging diseases go global. Mark E. J. Woolhouse. 21 February 2008, *Nature* 451, 898-899. <http://www.nature.com/nature/journal/v451/n7181/pdf/451898a.pdf>

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