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Major article

Emerging infectious diseases: Focus on infection control issues for novel coronaviruses (Severe Acute Respiratory Syndrome-CoV and Middle East Respiratory Syndrome-CoV), hemorrhagic fever viruses (Lassa and Ebola), and highly pathogenic avian influenza viruses, A(H5N1) and A(H7N9)

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Over the past several decades, we have witnessed the emergence of many new infectious agents, some of which are major public threats. New and emerging infectious diseases which are both transmissible from patient-to-patient and virulent with a high mortality include novel coronaviruses (SARS-CoV, MERS-CV), hemorrhagic fever viruses (Lassa, Ebola), and highly pathogenic avian influenza A viruses, A(H5N1) and A(H7N9). All healthcare facilities need to have policies and plans in place for early identification of patients with a highly communicable diseases which are highly virulent, ability to immediately isolate such patients, and provide proper management (e.g., training and availability of personal protective equipment) to prevent transmission to healthcare personnel, other patients and visitors to the healthcare facility.

Dr William Stewart, U.S. Surgeon General, is alleged to have said in the late 1960s, "it is time to close the book on infectious diseases, and declare the war against pestilence won."[1] This widely repeated statement turned out to be an urban legend and never to have been said.[2] However, the "belief that infectious diseases had been successfully overcome was pervasive in the biomedical circles—including among a Nobel Laureate, medical Dean, and other thought leaders—from as early as 1948, and extending into the mid-1980s."[2] The discovery that the 1976 outbreak of pneumonia (Legionnaires' disease) was caused by a newly described bacteria, *Legionella* spp, was an awakening call for public health and infection control professionals.[3,4] The first reports of the disease later known as AIDS in 1978[5,6] and the discovery of the virus that causes AIDS,[7] now known as HIV, in 1983 further demonstrated that infectious diseases would continue to be a major source of morbidity and mortality for patients. Importantly, although *Legionella* spp turned out not to be a new human pathogen but one that had caused human diseases for centuries, HIV was a new pathogen to humans, and its origin was traced to simian immunodeficiency viruses in primates.[8]

The public health threats posed by emerging diseases have been well described in 2 reports from the Institute of Medicine, one in 1992 and one in 2001.[9,10] Since the discovery of *Legionella* and HIV, many emerging infectious diseases have had important infection control implications. This review will focus on several of the most important threats, including novel coronaviruses (severe acute respiratory disease [SARS] and Middle East respiratory syndrome [MERS]), hemorrhagic viruses (Lassa, Ebola), and novel influenza viruses, and the infection control strategies required to mitigate the associated public health threat posed by these viruses.

EMERGING INFECTIOUS DISEASES

Definitions

The World Health Organization defines an emerging infectious disease as "one that has appeared in the population for the first time,

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or that may have existed previously but is rapidly increasing incidence or geographic range."[11] The Centers for Disease Control and Prevention (CDC) define emerging infectious diseases as follows[12]:

- New infections resulting from changes in or evolution of existing organisms.
- Known infections spreading to new geographic areas or populations.
- Previously unrecognized infections appearing in areas undergoing ecologic transformation.
- Old infections re-emerging as a result of antibiotic resistance in known agents or breakdowns in public health measures.

Factors in the emergence of infectious diseases

In 1985, Wilson described the basic concepts in infectious disease emergence as follows[13]:

- Emergence of infectious diseases is complex.
- Infectious diseases are dynamic.
- Most new infections are not caused by genuinely new pathogens.
- Agents involved in new and re-emergent infections cross taxonomic lines to include viruses, bacteria, fungi, protozoa, and helminths.
- The concept of the microbe as the cause of disease is inadequate and incomplete.
- Human activities are the most potent factors driving disease emergence.
- Social, economic, political, climactic, technologic, and environmental factors shape disease patterns and influence emergence.
- Understanding and responding to disease emergence require a global perspective, conceptually and geographically.
- The current global situation favors disease emergence.

An important concept listed by Wilson is that most new and emerging infections are zoonotic diseases that have jumped taxonomic lines to infect humans. Of the approximately 1,400 known human pathogens, 58% are zoonotic, including 73% of the 117 that meet the definition for emerging or re-emerging infectious pathogens.[14] Importantly, all of the pathogens that are the focus of this article are zoonotic. A more complete list of pathogens considered to have emerged via a species jump have been published.[15] Karesh et al have reviewed how zoonotic diseases result from natural pathogen ecology and how other circumstances, such as animal production, extraction of natural resources, and antimicrobial application, change the dynamics of disease exposure to human beings.[16] The stages in emergence of pandemic zoonotic diseases have also been reviewed.[17-19] Morse et al described 3 stages in emergence of zoonotic diseases: (1) pre-emergence (encroachment into wildlife habitat and change in land use); (2) localized emergence (expansion of the wildlife–human being interface, for example Ebola virus); and (3) pandemic emergence (international travel, for example SARS, HIV and AIDS).[18] Pike et al described 5 stages in zoonotic disease emergence: (1) exclusive to animals; (2) primary human infections only; (3) limited human-to-human transmission; (4) sustained human-to-human transmission; and (5) exclusive to humans.[17]

The 1992 Institute of Medicine report on microbial threats listed the factors in infectious disease emergence as follows: (1) ecological changes, including those caused by economic development and land use (agriculture: dams, changes in water ecosystems; deforestation/reforestation; flood-drought; famine; climate changes); (2) human demographics and behavior (societal events: population growth and migration; war or civil conflicts; urban decay; sexual behavior; intravenous drug use; use of high-density facilities); (3) international travel and commerce (worldwide movement of goods and people; air travel); (4) technology and industry (globalization of food supplies; changes in food processing and packaging; organ or tissue transplantation; drugs causing immunosuppression; widespread use of antibiotics); (5) microbial adaptation and change (microbial evolution, response to selection in the environment); and (6) breakdown in public health measures (curtailment or reduction in prevention programs; inadequate sanitation and vector control measures).[9,20] A more recent article listed the following factors as influencing new and re-emerging infections: exotic pets, exotic foods (eg, bush meat), companion animals, alterations in livestock management, acquisition of new virulence factors, pathogen adaptation to new host species, changes in land use, tourism, translocation of infected animals or persons, and climate changes influencing arthropods.[21]

EMERGING INFECTIOUS DISEASES OF INFECTION CONTROL IMPORTANCE

Overview

In the last 35 years, many emerging infectious diseases of infection control importance have been described (Table 1).[22-24]

Table 1
Selected emerging diseases of infection control importance

Disease (initial location)	Cases (United States)	Outcome	Person-to-person transmission	Patient-to-HCP transmission	Infection control risk	Year
Legionnaires' disease	Unknown (thousands)	Endemic and epidemic	No	No	High	1976-present
HIV (Africa)	Millions (thousands)	Ongoing epidemic	Yes (blood exposure, organ transplantation, vertical, sexual)	Yes (blood exposure)	Moderate	1978-present
vCJD	Hundreds	Controlled	Yes (blood, theoretically via contaminated medical instruments)	No	Low	1996
West Nile fever	(Thousands)	Endemic	Yes (blood transfusions, vertical, organ transplantation)	No*	Low	1999
SARS (China)	~8,000 (8)	Controlled	Yes (droplet, contact, airborne?)	Yes	High	2003-2004
Monkeypox (Africa)	(37 confirmed, 10 probable)	Eliminated in United States	Yes (droplet, contact)	Yes†	High	2003
MERS (Middle East)	Thousands (2)	Controlled	Yes (droplet, contact)	Yes	High	2014-present
Ebola (West Africa)	Thousands (4)	Controlled United States, reduced Africa	Yes (contact, sexual)	Yes	High	2014-present

HCP, health care personnel; *MERS*, Middle East respiratory syndrome; *SARS*, severe acute respiratory syndrome; *vCJD*, variant Creutzfeldt-Jakob disease.
*Infection via a needlestick theoretically possible.
†No HCP developed infection during the U.S. outbreak but patient-to-HCP transmission described in Africa.