

Emerging Infectious Diseases¹

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Infectious diseases are illnesses caused by the presence and activity of one or more pathogenic agents including viruses, bacteria, fungi, protozoa, multicellular parasites and abnormal proteins called prions. They are transmitted through a variety of means including direct or indirect contact; ingestion (in water or food); transmission of body fluids; inhalation of airborne particles and droplets; transmission by vectors such as mosquitoes, fleas, and ticks; and others.

What are Emerging Infectious Diseases

Emerging infectious diseases (EID) are those that have newly appeared or that have existed in the past but are now rapidly increasing in frequency, geographic range, or both. The U.S. Institute of Medicine defines emerging infections as: "... those whose incidence in humans has increased within the past two decades or threatens to increase in the near future. Emergence may be due to the spread of a new agent, to the recognition of an infection that has been present in the population but has gone undetected, or to the realization that an established disease has an infectious origin. Emergence may also be used to describe the reappearance (or "reemergence") of a

known infection after a decline in incidence." (Lederberg *et al.* 1992).

Some Examples of Emerging Infectious Diseases

Different infectious diseases could be considered "emerging" or "re-emerging" depending upon one's definition of the terms. The World Health Organization and the U.S. Centers for Disease Control have described over 100 infectious diseases affecting humans and animals as recently increasing or threatening to increase in geographic range, epidemic activity, and/or severity. Some, like blue tongue and visceral stomatitis affect mainly animals, but others are of concern to human health. The most common of these are listed in Table 1 and are briefly described below.

AIDS - AIDS (acquired immune deficiency syndrome) is a suite of conditions that result from infection with the human immunodeficiency virus (HIV). HIV attacks the immune system and compromises its ability to fight infections and certain cancers. The term "AIDS" is usually applied to the advanced stages of HIV infection. HIV is spread by the exchange of body fluids such as semen and blood.

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It can also be transmitted through organ transplants and from mother to fetus. Although at present time there is no cure for HIV infection, scientists have developed drugs that can help fight both HIV and the related infections and cancers. Survival rates have increased due to advances in drug therapy, and progression of HIV disease has decreased in developed countries where antiretroviral drugs are available.

Anthrax (<http://edis.ifas.ufl.edu/MB001>) - Anthrax is mainly a disease of herbivorous animals such as sheep, horses, and cattle. In humans, the disease usually occurs only in people who work with these animals or their products. The causative agent, the bacterium *Bacillus anthracis*, can cause three different kinds of disease: cutaneous anthrax, intestinal anthrax, and pulmonary anthrax. All three types can be fatal. Cutaneous anthrax is characterized by skin ulcerations with black necrotic areas and swelling of the lymph glands. Inhalation anthrax causes severe breathing problems and shock and is usually fatal. Intestinal anthrax causes nausea, vomiting and fever, followed by vomiting blood and severe diarrhea.

Antimicrobial and insecticide resistance - Widespread use of antimicrobials has spurred evolutionary adaptations that enable bacteria and other microbes such as viruses, fungi, and parasites to survive these powerful drugs. Antibiotic resistance can cause significant danger and suffering for people who have common infections that once were easily treatable with antibiotics. Tuberculosis, staph. infections, gonorrhea, malaria, and childhood ear infections are just a few of the diseases that have become hard to treat with antibiotic drugs. In an analogous fashion, many insects that transmit pathogens that cause diseases are becoming resistant to the insecticides used to control them which sometimes results in control failures and compromises the ability to use vector control as a disease prevention mechanism.

Botulism (<http://edis.ifas.ufl.edu/FS104>) - Botulism is caused by several nerve toxins produced by the bacterium *Clostridium botulinum*. It can cause paralysis and death. Foodborne botulism is caused by eating foods that contain botulism toxins; Infant

botulism results from consuming spores of the bacteria which then grow in the intestines and produce the toxins; Wound botulism is caused by toxins produced in wounds infected with the botulism bacteria. Symptoms of botulism include double and/or blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth, and muscle weakness. If untreated, these symptoms may progress to cause paralysis of the arms, legs, trunk and respiratory muscles and can result in death due to respiratory failure. A purified form of one of the toxins released by *C. botulinum* (Botulinum toxin Type A) forms the basis of the anti-wrinkling product Botox®. This product is used in tiny amounts to relax the action of some facial muscles that cause wrinkles in the forehead, around the eyes, and frown lines between the eyebrows.

Campylobacteriosis

(<http://edis.ifas.ufl.edu/FS098>) - This disease is caused by bacteria of the genus *Campylobacter*. These organisms are transmitted via the oral route and are normally found in wild birds, poultry, pigs, cattle, domesticated animals, unpasteurized milk and contaminated water. Symptoms of the disease are flu-like, but some individuals may develop nerve disorders such as Guillain-Barré syndrome and respiratory complications. Of these, about 5-10% may die, and 15-20% may experience permanent nerve damage.

Chagas disease (<http://edis.ifas.ufl.edu/IN650>) - Chagas disease, is a potentially fatal, chronic disease that currently affects twelve million people throughout Mexico, Central and South America. The disease is caused by a protozoan parasite, *Trypanosoma cruzi*. This parasite is transmitted to humans and animals by triatomine bugs, commonly referred to as "kissing bugs" (Figure 1). *T. cruzi* is not transmitted to humans directly by the bite of the infected insect. Triatomine bugs defecate while blood-feeding. If the insect is infected with the parasite, the latter can enter the bloodstream when the host scratches the irritated bite wound. Acute infections can be fatal, but most humans survive acute infection. Chronic infection of the cardiac muscle will eventually result in cardiac failure and death of the host. Symptoms of acute infection include swelling of the eye and surrounding area; fever; skin

rash; and enlarged lymph nodes, liver, and/or spleen. Among the symptoms of chronic infection are heart palpitations, dizziness, chest pain, fainting, and cardiac failure



Figure 1. Triatomine bugs can transmit Chagas disease. Credits: S.A. Kjos - Texas A&M University

Chikungunya (<http://edis.ifas.ufl.edu/IN696>) - Chikungunya is a virus that can be transmitted to humans by mosquitoes. The virus (CHIKV) is related to other alphaviruses like Ross River, Sindbis, and Venezuelan equine encephalitis viruses. Symptoms include fever, chills, headache, rash and severe joint pain with or without swelling. Chikungunya outbreaks with 100's of thousands of cases were reported from Africa and Southeast Asia in 2005-2006.

Cholera: Cholera is an acute diarrheal disease caused by the bacterium *Vibrio cholerae*. It is acquired by eating contaminated food or drinking contaminated water. It has a worldwide distribution and outbreaks can occur in any part of the world where water supplies, sanitation, food safety, and hygiene are inadequate. The primary symptom of cholera is massive diarrhea, but symptoms may also include muscle and stomach cramps, vomiting and fever in early stages. Treatment consists of rehydration and electrolyte replacement. Treatment with antibiotics may reduce duration and symptoms, but antibiotic resistance is common.

Prion disease, Creutzfeldt-Jakob disease - A prion is a proteinaceous transmissible agent that causes abnormal folding of certain brain proteins resulting in brain damage and death. General symptoms of prion disease include loss of motor control, dementia, paralysis, wasting, and eventually death. Prions are thought to be responsible for

scrapie, mad cow disease, and chronic wasting disease of animals, and Creutzfeldt-Jakob disease (CJD) in humans (but see below). CJD is an incurable neurodegenerative disorder that usually leads to death within one year. CJD is believed to occur by transformation of the normal prion proteins into abnormal prions. Much less frequently, CJD can occur because of inherited mutations of the prion protein gene. These inherited forms can give rise to Gerstmann-Straussler-Scheinker syndrome and fatal familial insomnia. Although bovine spongiform encephalopathy (mad cow disease) and CJD are not directly related, a variant of CJD, vCJD appears to be caused by the same agent as mad cow. vCJD has different genetic profile and different clinical and pathological characteristics than CJD. Recent research suggests that the abnormal protein itself may not be infectious, but is a pathological result of an infectious virus binding to this host protein (Manuelidis *et al.* 2007, <http://www.yale.edu/opa/newsr/07-01-30-02.all.html>)

Dengue (<http://edis.ifas.ufl.edu/IN699>) - Dengue is a human disease caused by a virus (DENV) transmitted by mosquitoes (Figure 2). Dengue occurs in many tropical and subtropical regions of the world, predominantly in urban-suburban areas. It is the most important arboviral disease of humans, affecting 50-100 million persons annually. Symptoms of dengue include high fever, severe headache, pain behind the eyes, severe joint and muscle pain (hence the name "break-bone fever", often used to describe the disease), nausea, vomiting, and skin rash. Dengue hemorrhagic fever (DHF) is a potentially fatal complication characterized by high fever, damage to lymph and blood vessels, bleeding from the nose, gums, and from under the skin, enlargement of the liver, and circulatory failure. The symptoms may progress to massive bleeding, shock and death (dengue shock syndrome). DHF symptoms usually manifest themselves 6-10 days after infection.

E. coli (<http://edis.ifas.ufl.edu/FS097>) - *Escherichia coli* is a bacterium normally found in the digestive tract of humans and animals. Some strains of the bacterium (in particular strain O157:H7), however, are extremely toxic and cause severe damage to the intestinal tract lining of those infected. These bacteria are primarily transmitted through



Figure 2. The yellow fever mosquito, *Aedes aegypti*, can also transmit other viruses including the dengue virus.
Credits: Jim Newman

fecal contamination. Symptoms of infection include watery and/or bloody diarrhea, fever, nausea, severe abdominal cramping, and vomiting. Treatment includes rehydration and administration of antidiarrheal agents. There is no evidence that antibiotics improve the course of the disease.

Flu - The flu is a contagious respiratory disease caused by the influenza virus. Symptoms can be mild to severe and can sometimes be fatal. Complications of flu can include bacterial pneumonia, ear infections, sinus infections, dehydration, and worsening of chronic medical conditions, such as congestive heart failure, asthma, or diabetes. The virus is spread by inhalation of virus particles disseminated by coughing or sneezing of infected persons. The virus can also be acquired by touching infected surfaces and then bringing the infected part of the body (such as the hand or arm) near the mouth or nose. Yearly flu vaccines are available and recommended for those at risk of complications such as the elderly and people with compromised immune systems.

Hantaan - Hanta viruses are carried primarily by rodents and can infect humans who breathe contaminated dust after disturbing or cleaning rodent droppings or nests, or who live or work in rodent-infested settings. The major diseases caused by Hanta viruses are hantavirus pulmonary syndrome (HPS) and hemorrhagic fever with renal syndrome (HFRS). Regions especially affected by HFRS include China, the Korean peninsula, and northern

and western Europe. Regions with the highest incidences of HPS include Argentina, Chile, Brazil, the United States, Canada and Panama. Symptoms of HPS include fatigue, fever, and muscle aches followed by coughing and shortness of breath as the lungs fill with fluid. Symptoms of HFRS include fever, fatigue and muscle pain headache, dizziness, vomit, nausea or diarrhea followed by hemorrhaging and serious kidney failure.

Lassa fever - Lassa fever is an acute viral illness that has been reported from West Africa. While Lassa fever is asymptomatic or causes only mild symptoms in about 80% of people infected, the remaining 20% have a severe multisystem disease. Lassa fever is also associated with occasional epidemics, during which the case-fatality rate can reach 50%. The virus is carried by rodents, and humans can become contaminated by exposure to rodent feces or urine, or by inhalation of particles contaminated by rodent excretions. Principal symptoms of the disease include fever, pain behind the chest wall, sore throat, back pain, cough, abdominal pain, vomiting, diarrhea, conjunctivitis, facial swelling, protein in the urine, and mucosal bleeding. Neurological problems have also been described.

Leishmaniasis (<http://edis.ifas.ufl.edu/IN705>) - Leishmaniasis is a disease caused by parasitic protozoans of the genus *Leishmania* that are transmitted to humans by sandflies of the subfamily Phlebotominae. The disease can attack the skin, mucous membranes, liver, spleen and bone marrow. Over 20 different *Leishmania* species can infect humans and cause a wide spectrum of symptoms that range from self-healing skin ulcers to severe life-threatening disease. Leishmaniasis occurs in Mexico, Central America, and South America (except Uruguay and Chile), southern Europe, Asia, the Middle East, and Africa, particularly east and north Africa. In the United States, rare cases of the cutaneous form of the disease have been reported from southern Texas, but no cases of visceral leishmaniasis are known to have been acquired in the U.S. An enzootic (present in animals) transmission cycle involving *Leishmania mexicana* in Texas has been described, indicating that cutaneous leishmaniasis may be more common than previously thought. In 2000, public health authorities in the

United States, discovered that hunting dogs in 21 U.S. states and the Canadian province of Ontario were infected with *Leishmania infantum*, a species that can cause visceral leishmaniasis. The infection appears to be widespread in foxhounds, but so far transmission appears to be limited to dog-to-dog mechanisms. However, if the local form of *L. infantum* becomes adapted for transmission by indigenous sandflies, the chances of human infection will be greatly increased.

Lyme Disease (<http://edis.ifas.ufl.edu/IN121>) - Lyme disease is caused by the bacterium *Borrelia burgdorferi* which is transmitted between mammals by the black-legged tick, *Ixodes scapularis*. The most common early indication of Lyme disease in humans is a rash, followed by fever, flu-like symptoms, chills, headache and fatigue. Later symptoms may include joint pain, headache, facial paralysis, myocarditis (inflammation of the heart muscle), and heart block. Most cases of Lyme disease can be successfully treated with antibiotics.

Malaria (<http://edis.ifas.ufl.edu/MG103>) - Malaria in humans is a disease caused by any one of four species of microscopic protozoan parasites in the genus *Plasmodium* and transmitted by mosquitoes in the genus *Anopheles*. Symptoms vary widely depending upon the individual's overall health and the species of parasite. In general symptoms of malaria include exhaustion, headache, anorexia, nausea and vomiting, and high fever. As recently as 1935, malaria caused 4,000 deaths every year in the United States, but its incidence was reduced to almost 0 by the 1950s. Recently, the frequency of malaria reports from U.S. locations has increased and includes cases of locally acquired disease in Florida.

O'nyong'nyong fever - The O'nyong'nyong virus (ONNV) is closely related Chikungunya virus and is primarily transmitted by anopheline mosquitoes in Africa. Symptoms of infection include inflammation of the joints, rash, fever, chest pain, and lethargy.

Oropouche fever - Oropouche fever is a viral infection transmitted by biting midges of the genus *Culicoides* and mosquitoes. It occurs in the Amazonian region of South America, the Caribbean, and Central America. Symptoms include chills,

headache, anorexia, muscle and joint pain and vomiting, and sometimes inflammation of the tissues surrounding the central nervous system (meningitis). Large epidemics are common, but patients usually recover fully.

Plague - Plague is caused by the bacterium *Yersinia pestis*. The bacterium is usually transmitted to humans through the bite of rodent fleas or by handling infected animals. Plague outbreaks still occur in certain regions of the world. In the United States plague presently occurs as scattered cases in rural areas (an average of 10 to 15 persons each year). Symptoms of the disease include fever, headache, and painfully swollen lymph nodes (buboes). If not treated with antibiotics, the bacteria can invade the bloodstream and produce potentially fatal septicemia and lung infection (plague pneumonia). The bacterium can also be spread by coughing or sneezing of plague pneumonia patients.

Rift Valley Fever - This is predominantly an animal disease that can sometimes infect humans and lead to high morbidity and mortality. It is caused by a virus (RVF) of the family Bunyaviridae that is transmitted by *Culex* mosquitoes. Symptoms may include fever, headache, muscle pain, backache, sensitivity to light and vomiting. A small proportion of patients (0.5-2%) may develop more severe symptoms including eye disease, inflammation of the brain and surrounding tissues or haemorrhagic fever. Fatalities are usually associated with those patients that develop haemorrhagic fever. The disease is particularly prevalent in Africa and the Arabian Peninsula, where it can cause substantial losses in domestic livestock and 1000's of human cases.

SARS - Severe acute respiratory syndrome is a disease caused by infection with a new coronavirus (SARS Co-V). It is spread by close person-to-person contact, particularly by respiratory droplets or when a person touches a surface or object contaminated with infectious droplets and then touches his or her mouth, nose, or eye(s). It is also possible that the SARS virus might spread more broadly through the air (airborne spread) or by other ways that are not now known. There has been one major epidemic to date, between November 2002 and July 2003, with 8,096 known cases of the disease,

and 774 death, mostly in China (including Mongolia and Hong Kong), Taiwan, Singapore, Vietnam and the Philippines. An outbreak in Canada (251 cases, 43 deaths), and 27 cases in the United States (eight confirmed), were all associated with travel to epidemic areas. Currently, no specific treatment exists for SARS, although various treatments have been tried with unclear success.

Salmonellosis (<http://edis.ifas.ufl.edu/FS096>) - *Salmonella* are bacteria that are widespread in the environment and can cause diarrheal illness in people. A small percentage of cases can develop a suite of debilitating long-term symptoms known as Reiter's Syndrome that include joint pain, swelling and irritation of the eyes, and sometimes painful urination. Good personal hygiene and sanitary food product preparation, handling, and storage can go a long way towards preventing the disease. Treatment includes replacement of fluids and electrolytes and antibiotics in patients with serious infections.

Shigellosis (<http://edis.ifas.ufl.edu/FS128>) - Shigellosis is a bacterial disease characterized by sudden and severe diarrhea (gastroenteritis or bacillary dysentery). *Shigella* thrives in the human intestine and is commonly spread through both food and person-to-person contact. Some persons who are infected may show no symptoms at all, but may still pass the *Shigella* organism to others. As in salmonellosis, Reiter's Syndrome may occur in a small percentage of the cases. Treatment consists principally in keeping up nutrition and avoiding dehydration. Antibiotics may not be necessary, except for the more severe infections

Sindbis - This virus (SINV) is very widespread and occurs in most continents. It produces fevers, headaches, general weakness, rash and joint pain. It is transmitted primarily by *Culex* mosquitoes. Symptoms of infection include joint pain, fatigue, nausea, muscle pain, headache, low fever, and itchy rash throughout the body.

Staphylococcal infection - Staph. infections are caused by *Staphylococcus* bacteria and are usually associated with poor personal hygiene and poor food handling and preparation. Staph. infections can spread through the air, on contaminated surfaces, and from person to person. Staphylococci can cause many

types of infections, for example, *Staphylococcus aureus* can infect wounds, it can cause food poisoning by releasing toxins into poorly handled food, and toxic shock syndrome by releasing superantigens into the blood stream. Methicillin-resistant *Staphylococcus aureus* (MRSA) has recently become a major cause of hospital-acquired infections and *S. saprophyticus* has been implicated in genitourinary infections in women. Although most staphylococci are resistant to penicillin, other antibiotics work well against the infection.

Streptococcal infection - Streptococcal (strep.) infections are caused by group A *Streptococcus* and can range from a mild skin infection or sore throat to severe, life-threatening conditions. Diseases associated with strep. infections include strep. throat, impetigo, cellulitis, erysipelas (St. Anthony's fire), scarlet fever, toxic shock syndrome, necrotizing fasciitis (flesh eating disease), and others. Treatment consists primarily of antibiotic and supportive therapy. Transmission is usually by contact with saliva or nasal discharge of infected persons, but there have been reports of transmission through contaminated foods.

Tuberculosis - Tuberculosis is primarily a respiratory disease that is spread by coughing and sneezing. It is caused by bacteria in the genus *Mycobacterium*, principally *M. tuberculosis*, that attack mainly the lungs, but can attack almost any part of the body. Symptoms include persistent cough, weight loss, loss of appetite, fever, night sweats and coughing up blood. Most people who become infected do not develop TB disease because their body's defenses protect them. TB is an increasing and major world wide problem, especially in Africa where the spread has been facilitated by AIDS. Treatment consists of antibiotics, and there is a vaccine that is effective for children, but not for adults.

Tularemia - Tularemia (rabbit fever) is caused by the highly infective bacterium *Francisella tularensis* and is typically found in animals, especially rodents, rabbits, and hares. Tularemia has been reported from all U.S. states except Hawaii. Symptoms include skin ulcers, swollen lymph glands, inflamed eyes, sore throat, mouth sores, diarrhea, and

pneumonia. If the bacteria are inhaled, symptoms can include abrupt onset of fever, chills, headache, muscle aches, joint pain, dry cough, and progressive weakness. The disease can be transmitted to humans by infected ticks, by handling an infected animals, by ingestion of infected water, soil, or food, or by inhalation. Tularemia is not spread directly from person to person.

West Nile (<http://edis.ifas.ufl.edu/IN117>) - West Nile virus (WNV) is carried by mosquitoes and if transmitted to humans, it can cause severe encephalitis. Symptoms of infection include headache, high fever, neck stiffness, disorientation, coma, convulsions, muscle weakness and paralysis. Most humans, however, do not develop clinical symptoms after infection. WNV was first isolated in 1937, from a woman in the West Nile province of Uganda in Central Africa. Epidemics of West Nile have occurred in Israel, France, South Africa, and Romania. West Nile virus was first documented in the United States in New York City during an epidemic in August 1999 and has since spread throughout the country resulting in ca. 25,000 human cases. A vaccine is available for horses, but not for humans.

Causes of Emergence/Re-emergence

The causes of emergence or re-emergence are many and vary widely between diseases, and even for the same disease in different geographic areas. Among the most common reasons for disease emergence and re-emergence are:



Figure 3. Population growth and rapid urbanization may result in overcrowded and unsanitary conditions. Credits: author

- Continued global population growth and rapid urbanization often results in overcrowded and unsanitary conditions for city dwellers (Figure 3). Lack of clean water and overall hygiene result in fertile breeding grounds for infectious diseases and their vectors, and crowded conditions raise the risk of respiratory diseases and those transmitted through direct contact.
- A large proportion of the recent and future population growth is/will be in tropical and sub-tropical developing regions. Human encroachment on tropical forests brings populations with little or no resistance to disease in contact with disease organisms or their vectors and greatly increase the potential for outbreaks of disease.
- Many developing areas are still going through economic and social crisis which weaken the health systems in some areas, often to the point of collapse, and prevents others from even developing minimal public health infrastructures. This allows diseases that were once under control and/or should be controllable to flourish due to inadequate resources. Sometimes the disease load itself is a big contributor to the social/economic crisis in certain countries; for example in many African nations, malaria is a major obstacle to social and economic development.
- Environmental change. Many factors influence the burden of infectious disease, and environmental factors change the distribution and impact of infections through many mechanisms (Wilson 2000). For example, deforestation, with fragmentation of habitat, increases the edge effect, which then promotes pathogen–vector– host interactions; or some infectious diseases may emerge or re-emerge as a result of a pathogen invading a niche newly created or recently vacated as a result of environmental change. Among the human-induced environmental changes that affect infectious disease risk are: deforestation, road construction, irrigation, dam building, intensified crop and animal production systems, urban sprawl, poor sanitation, and pollution. See

Wilson (2000) for a review of the topic and some specific examples.

- Migration, and the movement and encampment of millions of people displaced by wars, civil instability, or natural disasters create conditions extremely favorable for infectious disease epidemics, (e.g., crowding, unsanitary conditions, malnutrition, exposure to new diseases, and others). Furthermore, mass movements of people are extremely effective in carrying diseases to new areas.
- Increased international travel, commerce, and tourism provide efficient transport for disease-causing organisms and/or their vectors. They also greatly increase the exposure of people to "new" diseases for which they have little or no resistance.
- Changes in the global commerce of livestock and foodstuffs, including marketing, shipping, and storage increases opportunities for infectious disease outbreaks.
- Changes in human sexual behavior have greatly increased the prevalence of sexually transmitted diseases (STDs). In some cases, other infectious diseases can increase susceptibility to, or severity of STDs such as AIDS, and vice-versa.
- The indiscriminate use of pesticides and antimicrobials have given rise to widespread resistance in the target organisms thus making it more difficult to control diseases and/or their vectors. The problem is becoming so serious that some (e.g. the National Institute of Allergy and Infectious Diseases of the National Institutes of Health) consider antimicrobial resistance itself as an EID.
- New strains of old diseases with different immunological characteristics, increased virulence, and different responses to antibiotics are often responsible for new outbreaks of disease. Microbes may suddenly emerge as disease threats by acquiring new capacities for initiating infections and disease or by altering the human host's natural ability to mount an effective immune response. Examples include

influenza, cholera, mad cow, tuberculosis, and others.

- Immunosuppressed hosts: An increase in people with suppressed immune systems increases the risk of infection with other diseases, including EIDs. Links between frequency and severity of infectious diseases and immunosuppression (for example due to HIV infection or as part of cancer treatment or organ transplant therapy) have been established for many EIDs.

Are We at Risk?

Some EID such as AIDS, antibiotic resistant bacteria, tuberculosis, and others are already important in Florida and the United States. Others, such as dengue and dengue hemorrhagic fever, pose a credible threat to certain areas of the continental United States such as Florida and Texas, and have had outbreaks in Hawaii and Puerto Rico. Another group of EIDs may present a hazard only to travelers visiting or working in foreign locations where these diseases are endemic. Finally, the use of disease organisms such as *Bacillus anthracis* (anthrax), *Francisella tularensis* (tularemia), smallpox and ebola viruses, and others in bioterrorist attacks is now a real threat in many countries including the United States.

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Table 1. Some infectious diseases often considered as emerging or re-emerging.

DISEASE	AGENT	TYPE	TRANSMISSION
AIDS	Human Immunodeficiency (HIV)	virus	C, O
Anthrax	<i>Bacillus anthracis</i>	bacteria	C-I-Ig
Antimicrobial resistance	many	many	O
Botulism	<i>Clostridium botulinum</i>	bacteria	Ig-I
Bluetongue	<i>Orbivirus</i> (BTV)	virus	Vb
Campylobacteriosis	<i>Campylobacter</i> spp.	bacteria	Ig-C
Chagas disease			
Chikungunya	Alphavirus (CHIKV)	virus	Vb
Cholera	<i>Vibrio cholerae</i>	bacteria	I?
Creutzfeldt-Jacob	Prion (?)	protein	I, O
Dengue, DHF	Flavivirus (DENV)	virus	Vb
<i>Escherichia coli</i>	<i>Escherichia coli</i>	bacteria	Ig, C?
Flu	Influenza virus	virus	C, I, Ig
Hantaan	<i>Hantavirus</i> (HTNV)	virus	C, I
Lassa fever	<i>Arenavirus</i> (LASV)	virus	C, I, Ig
Leishmaniasis	<i>Leishmania</i> spp.	protozoan	Vb
Lyme disease	<i>Borrelia burgdorferi</i>	bacteria	Vb
Malaria	<i>Plasmodium</i> spp.	protozoan	Vb
Onyong-nyong	Alphavirus (ONNV)	virus	Vb
Oropouche	<i>Bunyavirus</i> (OROV)	virus	Vb
Plague	<i>Yersinia pestis</i>	bacteria	Vb
Rift Valley fever	Phlebovirus (RFV)	virus	Vb
SARS	SARS-Co-V	virus	I, Ig
Salmonellosis	<i>Salmonella</i> spp.	bacteria	Ig
Shigellosis	<i>Shigella</i> spp.	bacteria	Ig, C
Sindbis	Alphavirus (SINV)	virus	Vb
Smallpox	<i>Variola major</i>	virus	I, Ig, C
Staphylococcus	<i>Staphylococcus aureus</i>	bacteria	I
Strep infections	Group A <i>streptococcus</i>	bacteria	C, I, Ig
Tuberculosis	<i>Mycobacterium tuberculosis</i>	bacteria	I, Ig
Tularemia	<i>Francisella tularensis</i>	bacteria	Vb, I, Ig, C
West Nile virus	Flavivirus (WNV)	virus	Vb

C= contact, I= inhalation, Ig = ingestion, Vb = vector borne, O = other