Emerging and Re-Emerging Zoonoses

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Abstract: After world war II it was widely believed that human-kind was winning the battle with the microbial world due to the advent of safe and antimicrobial compounds against diseases, such as tuberculosis, typhoid and so on, vaccine against polio, diphtheria and pertussis, vast improvements in public sanitation and water/food quality and effective chemical pesticides to control insect vectors of disease. Many elements can contribute to the emergence of a new zoonotic disease, including microbial / parasitical / virologic determinants, such as mutation, natural selection and evolutionary progression; individual host determinants, such as acquired immunity and physiologic factors; host population determinants, such as host behavioral characteristics and societal, commercial and iatrogenic factors; and environmental determinants, such as ecologic and climatologie influences. In general, there is no way to predict when or where the next important new zoonotic pathogen will emerge or what its ultimate importance might be. A pathogen might emerge as the cause of a geographically limited curiosity, intermittent disease outbreaks, or a new epidemic. No one could have predicted the emergence or zoonotic nature of the BSE prion in cattle in the U. K. in 1986, the emergence or zoonotic potential of Sin Nombre Virus as the cause of hantavirus pulmonary syndrome in the southwest U. S. A. in 1993 and certainly not the species-jumping emergence of HIV as the cause of AIDS in 1981.

Key words: Microbial • Emerging • Zoonotic pathogen

INTRODUCTION

In 1969, the United States Surgeon General William H. Stewart even declared to the congress that: "it is time to close the book on infectious diseases, declare the war against pestilence won"[1]. However, word wide infectious and parasitic diseases still cause untold suffering and exact an enormous physical, economic and social toll on human existence, causing 33% of deaths world-wide, with more than half of the victims under the age 5 years. But the figure is much higher in developing countries. For example, in Africa it is estimated that 68% of all deaths are the result of infectious diseases. The actual burden of infectious disease deaths and illness may even be higher as an increasing body of evidence indicates that infectious agents may play a significant role in the etiolog of a wide range of chronic disease conditions, including cardiovascular disease, chronic pulmonary disease, arthritis and cancer.

In 1992, "new, reemerging or drug-resistant infectious whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future" were defined as "Emerging Infections". Previously, zoonoses were defined as "The diseases and infections which are naturally transmitted between vertebrate animals and man" (WHO, 1959). After that, who noted "zoonotic diseases caused either by totally new or partially new agents, or by microorganisms previously known, but now occurring in places or in species where the disease was previously unknown" as Emerging and re-emerging zoonoses (meslin, WHO. 1992).

While a significant of the burden of human illness due to infectious agent is the result of well-known infectious agent with human reservoirs, the majority of infectious agent known to afflict human are zoonotic. Zoonoses are diseases of animals that can also infect humans. Taylor et al catalogued 1709 species of infectious agents reported to cause disease in humans, including
viruses, prions, bacteria, rickettias, fungi, protozoa and helminthes in the year 2000. Of these, 832 (49%) are considered "emerging" disease, 73% (114) of which are zoonotic.

One year later he and his colleagues reclassified the human infectious agents and noted 1415 species of the agents, of those, 868 (61%) are considered zoonotic and 175 (12%) are considered "Emergent" diseases, 75% (132) of which are zoonotic. Thus, while a majority of infectious agents affecting humans are zoonotic, an even greater majority of emerging agents are zoonotic. Animals not only serve as a significant reservoir for agents infectious to humans, but also serve as a wellspring of new infectious agents introduced into the human population.

In general, an emerging disease is either new to science or is an existing disease with incidence increasing in a given place or population, such as West Nile Virus (WNV) in North America (an agent which gains the ability to infect new hosts), the highly pathogenic H1N1 avian influenza (which has caused hundreds of human cases in several countries since 1997 and 2004), or agents which evolve into new strains, such as the various antibiotic resistant strains of Staphylococcus aureus. In the past four decades, emerging disease episodes have increased in many countries of the world. High profile examples of emerging diseases include the human immunodeficiency virus (HIV), Ebola virus, severe acute respiratory syndrome (SARS) virus, the highly pathogenic H1N1 avian influenza virus, bovine spongiform encephalopathy (BSE-mad cow disease), antibiotic resistant staphylococcus aureus and antibiotic resistant mycobacterium tuberculosis. A preponderance of these agents are either directly zoonotic or, like HIV, have zoonotic origins. While the number of people affected by some of these agents is small, others inflict significant medical, social and economic burdens. The list of important emerging diseases is impressive indeed and, given what we know about disease ecology, it will only continue to grow. Nearly all of these emerging disease episodes have involved zoonotic infectious agents, that is, they have involved the transmission of the etiologic agent to humans from an ongoing reservoir life cycle in animals or arthropods, without the permanent establishment of a new life cycle in humans. Fewer episodes have involved species-jumping by the etiologic agent; that is, they derive from and ancient reservoir life cycle in animals but have subsequently established an new life cycle in humans that no longer involves an animals reservoir.

Some Major Bacterial Etiologic Agents of New Zoonoses Identified since 1976 Are:

- **1976** Capnocytophaga canimorsus
- **1977** Campylobacter spp.
- **1982** E. coli O157: H7
- **1982** Borrelia burgdorferi (Lyme disease)
- **1983** Helicobacter pylori and other spp.
- **1986** Ehrlichia chaffeensis (human monocytic Ehrlichiosis-HME)
- **1992** Bartonella henselae (cat scratch disease-CSD)
- **1994** Rickettsia felis (murine typhus-like)
- **1994** E. equi A. phagocytophila (HGE-human Granulocytotropic Ehrlichiosis)

Also, Some Major Viral Etiologic Agents of New Zoonoses Identified since 1990 Are:

- **1991** Guanarito virus (Venezuelan hemorrhagic fever)
- **1993** Sin nombre virus (Hantavirus pulmonary syndrome)
- **1994** Sabia virus (Brazilian hemorrhagic fever)
- **1994** Hendra virus (Equine morbillivirus)
- **1996** Anstralnian bat lyssavirus (Rhabdovirus)
- **1997** Menangle virus (Paramyxovirus)
- **1997** Influenza virus H1N1 (Hongkong)
- **1998** Nipah virus (Paramyxovirus)
- **1999** Influenza virus H5N1 (Hongkong)
- **2002** SARS virus (Corona virus) (Severe Acute Respiratory Syndrome)

**Disease Emergence:** Many elements can contribute to the emergence of a new zoonotic disease, including microbial/parasitical/virologic determinants, such as mutation, natural selection and evolutionary progression; individual host determinants, such as acquired immunity and physiologic factors; host population determinants, such as host behavioral characteristics and societal, commercial and iatrogenic factors; and environmental determinants, such as ecologic and climatologic influences[6].

The Institute of Medicine (IOM), in its 2003 publication Microbial Threats to Health: Emergence, Detection and Response, proposes a "Convergence model" of infectious disease emergence, which consists of four broad domains of factors that influence pathogen/host interactions and the resulting emergence of new diseases.

**These Four Are:**

- Genetic and Biologic factor,
- Physical and Environmental factors,
Ecologic factors and,
Social, Political and Economic factors. Within these
4 broad domains, the IOM identifies 13 more specific
factors, that belong to one or more of these domains.

These Specific Factors Consist Of:

- Microbial Adaptation and Chang,
- Human Susceptibility to Infection,
- Climate and weather,
- Physical Events,
- Changing Ecosystems,
- Economic Development and Land use,
- Human Demographics and behavior,
- Technology and Industry,
- International Travel and Commerce.
- Breakdown of Public Health Measures,
- Poverty and Social inequity,
- War and Famine and
- Lack of Political will.

In addition, the factor of intent to harm by
Bioterrorism (such as, the 2001 anthrax terrorist attacks in
the United State) should be added.

Emergence of new zoonotic pathogens seems to be
accelerating for several reasons, including global
human and livestock animal populations have continued
to grow, bringing increasingly larger numbers of
people and animals into close contact; transportation
has advanced, making it possible to circumnavigate
the globe in less than the incubation period of most
infectious agents; ecologic and environmental changes
brought about by human activity are massive; and
bioterroristic activities, supported by rogue governments
as well as organized amateurs, are increasing and in most
instances the infectious agents of choice seem to be
zoonotic [6].

In general, there is no way to predict when or where
the next important new zoonotic pathogen will emerge
or what its ultimate importance might be. A pathogen
might emerge as the cause of a geographically limited
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epidemic. No one could have predicted the emergence or
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Virus as the cause of hantavirus pulmonary syndrome
in the southwest U. S. A. in 1993 and certainly not the
species-jumping emergence of HIV as the cause of AIDS
in 1981. Consequently, investigation at the first sign of
emergence of a new zoonotic disease is particularly
important, although the investigation usually resembles
a field - and laboratory - based research project rather
than a typical case – control – based outbreak
investigation. This reality must drive strategic planning
for dealing with new zoonotic diseases.

The factors and mechanisms discussed above have
likely affected the emergence, distribution and prevalence
of zoonotic diseases in the world. In relation to factors
including environmental and distributions to the balance
of natural habitats, human demographice and behavior,
international travel and commerce, complications of
modern medicine, microbial adaptation and change and
the breakdown of public health measures, zoonotic
diseases emerge. Some emerging diseases are associated
with environmental changes that occur with economic or
agricultural development or changes in land use patterns.
Certainly, the development and growth of cities fueled by
an influx of migrants can foster the establishment of a new
infection in a population. Once established in a crowded
urban area, a disease can easily take root and can be
extremely difficult to eradicate. Other human activities that
disturb natural ecosystems, including road – building,
logging and irrigation projects, can also bring humans
into new areas while displacing microbes that must then
seek out new hosts. Changes in local climate, such as
drier, wetter, or warmer periods, can extend the range of
mosquitos and other disease vectors.

On other hand, in areas where populations are rapidly
expanding beyond the capacity of the local water / food
supplies, waterborn / food born infections can be
expected to create serious outbreaks of disease. Bacteria,
viruses and parasites can all thrive in untreated or
inadequately treated water system by contaminated feces.
In 1993, U. S. experienced one of the largest outbreaks of
waterborne disease ever reported. An estimated 403,000
people in the Milwaukee, Wisconsin, area were stricken
with zoonotic cryptosporidiosis, a parasitic infection that
causes severe diarrhea and is found increasingly in
unfiltered raw watter. Of the 44,000 people who sought
medical attention in the city, more than 4,000 had to be
hospitalized. City public health officials surmise that
heavy rains, snowmelt and runoff from nearby farms may
have overloaded the city's water treatment plants.
Cryptosporidia are resistant to chlorine and must be
removed from water supplies by mechanical filtration.
Also, food-related illnesses and death in the world are
increasing. In the U. S., it is estimated that annually food
borne diseases cause approximately more than 76 million
illnesses, 325,000 hospitalizations and 5000 deaths
(CDC, 1999). Some of the factors that contribute to the
epidemiology of food borne diseases are: diet, commercial
food service, new methods of food production, new or
Hantavirus – Hanta virus, one of the newest diseases, causes different symptoms (such as hemorrhagic fever, abdominal pain, or respiratory infection) depending on the strain of the virus. It appears in areas where litter and trash abound and rats and mice nest[12]. More than 100,000 cases have been reported in China. The disease is also found elsewhere in Asia and in Scandinavia, the Balkan region, much of Europe and recently in the United States[12].

The recent hantavirus outbreak in the Southwestern United States has been linked to a change in ecological conditions. The strain that hit New Mexico in 1999 causing a frequently lethal respiratory infection was transmitted by inhalation of airborne droplets of rodent urine and feces. Between 1999 and 1993, an unusually wet and mild winter led to increased adult rat and mouse survival and, in turn, an increased rodent population in the spring. As competition forced the rodents beyond their normal habitat in search of food, human contact with infected animals (and, hence, with the virus) also increased [13].

For the United States as a whole, as of June 1995, the CDC had confirmed 110 cases in 23 states, 50.9 percent of these were fatal. Now that tests that can diagnose hantavirus infection are available, it is clear that infection is more widespread than was initially expected and that the virus has probably been around for a long time [14]. In 1997, more than 164 cases in U. S. and more than 400 in Americas with mortality rate 45% had been confirmed.

Rift Valley Fever (RVF) – Some infectious diseases have been linked to the ecological changes brought about by dam construction; dams change the water flow and can cause water to puddle and serve as breeding sites for mosquitoes. In Senegal, the construction and activation of Diama Dam are believed to have led to the introduction of RVF, a disease never before seen in the region. Surprisingly, one third of inhabitants were found to have antibodies to the virus. Still, near the village of Keur Mecene upstream from the dam, 1987 epidemic caused 244 human deaths and more than 1,200 illnesses, as well as spontaneous abortion in sheep and cattle [14].

Dengue – Dengue virus, which is now the most important and fastest growing insect-borne viral infection in the world, is transmitted primarily by the Aedes aegypti mosquito. The mosquito vector that transmits dengue multiplies in any small pool of stagnant water, especially in discarded tires or other detritus that result from life in overcrowded urban areas. The disease, also known as "break–bone fever", produces severe headaches and disabling pain in muscles and joints. A far more serious form of the disease, hemorrhagic dengue fever or dengue shock syndrome, has a 40 to 50 percent fatality rate if it is left untreated [15].

In 1993, some 23,000 deaths from dengue and 250,000 cases of dengue were officially reported to WHO, a substantial increase over previous years. During the 1960s, dengue typically averaged about 30,000 cases per year, from 1985 through 1989, nearly 1 million cases were reported. However, even these numbers are likely to be underestimates, for every confirmed case of dengue, officials suspect that there are four additional cases that have either not been reported or have been misdiagnosed. In poor urban areas in the tropics, where mosquito-control programs are sparse or nonexistent, dengue is becoming an enormous problem. In Southeast Asia, dengue hemorrhagic fever (and dengue shock syndrome) is one of the leading causes of hospitalization and death among children. In many parts of the Latin America, dengue has reached epidemic proportions, even though the disease was believed to have been nearly eradicated in the 1960s. In addition, hemorrhagic dengue fever is increasing in incidence. Brazil has been hardest hit, with 88,039 confirmed cases of dengue and 105 cases of hemorrhagic dengue fever in the first 9 months of 1995, the year's unusually long wet season and high number of hurricanes are believed to be contributing to the severity of the epidemic, providing fertile breeding grounds for the Aedes aegypti mosquito[14].

Ebola virus – If the public needed a reminder that a deadly, infectious disease could emerge at any moment, they got one in the spring of 1995. Reports began trickling out of the city of Kikwit, zair, that the local hospital was being swamped with cases of hemorrhagic fever. Both WHO in Geneva and the CDC in Atlanta sent teams of experts to evaluate the outbreak, but even as the teams were arriving in Kikwit, blood samples that had been sent to the CDC confirmed that the illness was caused by the Ebola virus[16].

Although extremely deadly, the Ebola virus is not easily transmitted. Close contact with blood or other body fluids appears to be necessary. The CDC and WHO teams trained local health workers in proper infection control procedures, including the use of masks and gloves and the need to sterilized needles and surgical instruments.
Local Red Cross warned people not to perform a traditional burial ritual, which would expose them to infected body fluids. After several nervous weeks, WHO officials appeared confident that the epidemic was under control, although nearly 250 people died in the outbreak [17]. Health officials were especially relieved that the epidemic did not spread to Kinshasa, the capital city of 4 million less than 250 kilometers away.

But it certainly could have. The Ebola virus outbreak appears to have begun in the winter of 1994 – 1995, but it was not recognized until several months later. The illness has an incubation period of up to 3 weeks, although it may often be 1 week or less. During this time, the patient has no symptoms. It is easy enough to imagine a truck driver or riverboat captain becoming infected and bringing the disease into the capital before showing any symptoms and then swiftly spreading the disease to others. If the disease had not been recognized promptly when the patients began showing symptoms and were therefore most infectious, the capital could easily have had a public health disaster on its hands. And the disease could even conceivably have spread to other parts of the world via air travel.

The illness caused by the Ebola virus in just one of a number of new diseases such as Hantavirus that has emerged in recent years or that has "reemerged" in a new location or a more dangerous form. This phenomenon has sparked alarm among health officials worldwide. Although new diseases like that caused by the Ebola virus capture headline, the death toll from the latest outbreak fortunately remained in the hundreds.

West Nile Virus (WNV) – The West Nile Virus arrived in Texas, U. S. A, in 2002, first in the mosquito vector and avian reservoir populations, then spilled over into equine and human populations. Temperature, rainfall, human behavior and living conditions, immunologic naively within the animal and human populations, land sue and other factors play a role in the ongoing distribution, prevalence and incidence of this disease. For example, clogged pain gutters, storm drains and other water-collectiong items associated with urban and suburban environments create extensive breeding habitats for Culex quinquefaciatus, the predominant mosquito vector species of WNV in the eastern and southern portions of Texas. Irrigation canals in the El Paso area and the Texas Panhandle provide increased breeding habitat for Culex tarsalis, the predominant vector of WNV in those areas.

Socio economic, cultural and behavioral factors, among others, also affect the incidence of WNV infection [2,18,19].

Equine morbillivirus (EMV) – In 1994, horses on a property in Queensland developed acute respiratory distress with hemorrhagic manifestation – 14 of 21 infected horses died. A horse trainer and a stable hand became ill after nursing a sick horse – the trainer died. The disease was found to be caused by a previously unknown morbilivirus. Remarkably, in 1996 fruit bats (flying foxes) were found to be the natural host of the virus[6, 20].

Venezuelan Equine Encephalitis (VEE) – In 1971, as the virus of VEE crossed from Mexico into Texas, agricultural disease control authorities were prepared to start shooting and burying horses in a massive slaughter campaign. Scientist from CDC and the Middle America Research Unit (at the time a Unit of National Institutes of Health) provided the virologic and epidemiologic base to override the sanitary rifle strategy of agricultural authorities and the U. S. Army provided its then new TC83 vaccine. But, again in 1995, VEE epidemic had progressed from Venezuela and Colombia and jumped over the north[6].

Monkeypox virus In 2003, a Texas animal dealer imported a large shipment of wild – caught animals, primarily rodents, from Ghana in west Africa. An unknown number of these animals were infected with Monkeypox Virus, an ortopoxvirus closely related to Smallpox. A second animal dealer purchased some of these animals, transporting them to Iowa in an enclosed van with wild – caught prairie dogs. The prairie dogs became infected with monkeypox and were the sold or bartered to the public throughout several states, leading to 72 probable and confirmed cases of monkeypox in humans. This outbreak illustrates the risk of disease translocation associated with the international trade in animals and animal products[2, 6].

BSE Prion – Bovine Spongiform Encephalopathy (BSE) was first diagnosed in the united kingdom in 1986, as of 1997, more than 170,000 cattle had been reported as infected, but modern statistical methods have indicated that about one million cattle had been infected, roughly half of which entered the human food chain in the U. K. In 1995, the BSE agent "prion" was reported to be the cause of a new human zoonotic disease, new-variant Creutzfeldt – Jakob disease[6].

CONCLUSION

In addition to examples mentioned above, many emerging and reemerging infections are zoonoses that have emerged because Homo sapiens and its domestic animals are coming into contact with infectious agents that they haven't had contact with before or those we
haven't seen for a long time. In all cases, one of the most important points is the need for greater epidemiologic resources and better trained professional for dealing with human and animal diseases or with the zoonotic interface between the two. This training component requires consideration of all steps along the discovery to control continuum. Finally, in 1934, Hans Zinsser, an eminent professor of bacteriology at Havard University wrote in his book "Rats, Lice and History": "Infectious disease is one of the few genuine adventures left in the world. The dragons are all dead and the lance grows rusty in the chimney corner. About the only sporting proposition that remains unimpaired by the relentless domestication of a once free living human species is the war against those ferocious little follow creatures, which lurk in the dark corners and stalk us in the bodies of rats, mice and all kinds of domestic animals, which fly and crawl with the insects and waylay us in our food and drink and even in our love". Which is still true?

REFERENCES