

## PREVENTION AND CONTROL OF COMMUNICABLE DISEASES

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**Keywords:** Prevention, control, infectious, epidemics, eradication, elimination, spread, causes, symptoms, complications, transmission, treatment, children, mortality, developing countries, education, surveillance, incidence, vector, poverty, malnutrition, refugees, displaced people, antimicrobial, globalization, antibiotics, legislation, panic

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## Summary

Once thought to be diseases of the past, infectious diseases are on the rise as never before. At the end of the twentieth century, six major infectious diseases were responsible for approximately 90% of infectious disease mortality: acute respiratory infections, diarrheal diseases, AIDS, malaria, tuberculosis, and measles. As well as high rates of mortality, infectious diseases cause severe and long-term disability that often results in discrimination, stigmatization, and may have significant socioeconomic consequences. The emergence and reemergence of infectious agents previously considered a receding menace now threaten to reverse positive trends in incidence or prevalence worldwide. The prevailing optimism post-1950s that infectious diseases could be consigned to history has been replaced by a global alarm against a fatal complacency that is costing millions of lives every year.

An increase in populations and population displacement, alterations to the environment, climate changes, globalization, poverty, overcrowding, and poor sanitation favor the rapid spread of infectious diseases. Antimicrobial resistance has compromised the ability of antimicrobial agents to combat infectious diseases. Widespread misuse of antimicrobial drugs is at the root of this crisis.

The international community recognizes that many of the key determinants of health—as well as the solutions to ill health—are the responsibility of sectors other than the health sector alone. At the beginning of the twenty-first century, two futures are possible: to build on the economic and scientific advances of the previous century to reduce the impact of infectious diseases, or to ignore the warning call to the international community that progress may be reversed and that infectious diseases will continue to escalate and be a burden on development.

## 1. Introduction

Throughout history, human populations have experienced major epidemics of infectious diseases, often resulting in large numbers of deaths, panic, disruption of trade, and

political instability. While all infectious diseases have the potential to spread, it is the rapid nature of the spread of epidemic diseases and the high mortality rate in newly affected populations that has marked the human psyche.

The public health movements of the late nineteenth century identified poverty, overcrowding, and poor sanitation as fertile ground for major epidemics, especially in urban areas. These discoveries and the development of effective treatments and vaccines in the first half of the twentieth century led to hopes that most infectious diseases could be eradicated.

The fight against infectious diseases worldwide is far from won, however. Since the early 1990s, the international health community has been sounding the alarm against a fatal complacency that is costing millions of lives every year (over 14 million in 2001 out of a worldwide total of over 56 million, representing 25% of total disease mortality). Many of these deaths are caused by epidemic-prone diseases such as measles, meningitis, and cholera. Epidemic-prone diseases are significant for two reasons: (1) many are currently causing large epidemics; (2) others have an increasing potential to become epidemics.

Many infectious diseases are termed *endemic* because they have a stable pattern of occurrence in a given population. *Epidemics* are defined as the occurrence of an infectious disease greatly in excess of expectation. However, many endemic diseases can cause epidemics if they spread to unprotected or previously unexposed populations. In addition, endemic diseases can rapidly become epidemic when the mode of transmission or vector changes. Many diseases now labeled endemic began with severe epidemics. A *pandemic* is a disease that is prevalent worldwide.

Epidemics do not always develop rapidly. For example, the human immunodeficiency virus (HIV) epidemic has taken decades to develop and spread, and still reaches previously unexposed populations each year. The long period during which an individual remains healthy masks the true lethality of the epidemic and explains why the disease has so much opportunity to spread. Beyond the most recent examples of epidemics, the question arises of the potential threat of others. Populations are permanently at risk not only of the recurrence of epidemics that can to a certain extent be predicted, but also of new pathogens whose occurrence and impact on human health are not known.

At the end of the twentieth century, international efforts were under way to rid the world of a certain number of infectious diseases. *Eradication* is the complete interruption of transmission of an infectious disease and the disappearance of the virus, bacterium, or parasite that caused the infection. *Elimination* is the reduction of incidence as a result of deliberate efforts, requiring continued control measures.

## **2. Infectious Diseases Causing High Mortality**

Six endemic infectious processes cause the highest burden of mortality worldwide. These leading six diseases, which cause almost 90% of infectious disease deaths, are: acute respiratory infections (including pneumonia and influenza), human

immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), diarrheal diseases, tuberculosis, malaria, and measles.

## **2.1. Acute Respiratory Infections**

Acute respiratory infections (ARIs) are estimated to have caused approximately 3.5 million deaths in 1998, 99% of which occurred in developing countries, among children aged under five years.

### **2.1.1. Pneumonia**

The deadliest of these, pneumonia, causes more childhood deaths than any other infectious disease. The causative agent, *Streptococcus pneumoniae*, is carried in the noses and throats of healthy people worldwide, but infants and young children have little resistance to it or to *Haemophilus influenzae*, the second most frequent bacterial cause of childhood pneumonia in developing countries. Spread by droplets in the air, these acute bacterial infections of the lungs typically begin with the sudden onset of shaking chills and fever. They can be treated by antibiotics, but providing antibiotics is not a simple matter in communities with little access to health care or health education. Families may delay seeking treatment for their child or not receive that treatment until it is too late. In poor countries, the shortage of doctors and health workers trained in the management of such cases and inadequate health infrastructures are significant factors in the high case-fatality rate.

### **2.1.2. Influenza**

Influenza is one of the oldest and most common diseases. It can also be one of the deadliest. Its ability to kill stems from the fact that the virus can mutate quickly, often producing new strains against which human beings have no immunity. When this occurs, mortality can be extremely high, such as during the 1918–1919 pandemic of “Spanish flu,” which killed between 40 and 50 million people worldwide and caused the largest number of deaths in the young and healthy age group of 20–39 years. Spread by airborne droplets and possibly also by direct contact, influenza occurs in seasonal epidemics, in temperate climates and North America and Europe during winter, and during the rainy season in the tropics. Symptoms include fever, headache, muscle pain, sore throat, and cough, and may develop into life-threatening pneumonia, especially among the elderly or those in poor health due to other underlying disease. An effective influenza vaccine may protect up to 80% of recipients when it is closely matched to the subtypes of virus in global circulation. To get the closest match possible, the vaccine composition needs to be updated each year on the basis of scientific information supplied by the World Health Organization (WHO) through a network of influenza monitoring centers around the world.

## **2.2. HIV/AIDS**

First identified in the early 1980s, HIV/AIDS has rapidly spread worldwide. It is estimated that at the end of 2001, 40 million people were living with the disease. HIV weakens the body’s natural defenses, or immune system, leaving it vulnerable to all

sorts of other infections. Normally, the body can resist many of these infections, but HIV gives them the opportunity to have a lethal impact. They are therefore known as opportunistic infections and AIDS is the collective name for them when they are related to HIV infection. HIV is essentially a sexually transmitted infection, although it can also be spread in other ways, including through contaminated blood or blood products, contaminated needles used by drug injectors, and from mother to baby before or around the time of childbirth. People infected with HIV can remain healthy for years, and the danger of this long incubation period is that individuals can infect others. Most infections are due to unprotected sexual intercourse in which one of the partners is HIV-positive.

Progression rates have changed dramatically in industrialized countries, where the introduction of highly active antiretroviral therapy in 1995 has contributed to decreases of up to 70% in the number of reported AIDS cases and AIDS-related deaths.

### **2.3. Diarrheal Diseases**

Diarrheal diseases are estimated to have caused approximately two million deaths during 1998, most of which were children under five living in developing countries. The most common cause is rotavirus, often occurring at the time of weaning, and death is a result of dehydration. It was long thought that contaminated water supplies were the main source of pathogens causing diarrhea, but it has now been shown that food can be responsible for up to 70% of diarrheal episodes. Infections due to pathogenic *Escherichia coli* are the most common cause of diarrhea.

### **2.4. Cholera**

Epidemics of cholera are frequent, and affect adults as well as children. At least seven cholera pandemics have been recorded since 1850. The seventh, caused by *Vibrio cholerae* O1 biotype El Tor, started in 1961 in Indonesia, spread to Peru in 1991 and then to other countries in South and Central America. In 1992, *V. cholerae* O139 was first detected in the Bay of Bengal and has since been identified in 10 other Asian countries. The number of reported cases increased nearly 100% in 1998 compared to 1997, on all continents. Africa was the most affected, with 72% of the global total and 29 countries reporting cases out of a total of 74 worldwide.

### **2.5. *Escherichia coli* O157:H7**

Since first being recognized as a human pathogen in 1982, enterohemorrhagic *Escherichia coli* has gained increasing notoriety. The best-known serotype is *E. coli* O157:H7. Symptoms include abdominal cramps and watery diarrhea that can develop into bloody diarrhea. In a small proportion of patients, particularly young children and the elderly, the infection can result in life-threatening complications, such as hemolytic uremic syndrome. The reservoir of the pathogen appears to be mainly cattle, and is transmitted through the consumption of contaminated foods such as raw or undercooked meat products and raw milk. Fecal contamination of water and food, as well as cross-contamination during food preparation, also leads to infection. The prevention of infection requires control measures at all stages of the food chain, from agricultural

production on the farm to processing, manufacturing, and preparation of food in commercial establishments and the domestic environment.

## 2.6. Rotavirus

Rotavirus is the most common cause of severe diarrheal disease in infants and young children all over the world. Almost all children are infected by the age of three to five years, and more than 125 million cases of diarrhea each year are attributed to rotavirus. It is estimated that rotavirus causes 25% of all deaths due to diarrheal diseases. The disease is characterized by acute onset of vomiting, fever, and profuse watery diarrhea. Although the infection is usually mild, severe disease may rapidly result in life-threatening dehydration if not appropriately treated. Rotavirus is transmitted by the fecal-oral route. Animal reservoirs are not known to exist. Immunity acquired during a child's first infections provides protection against severe disease on subsequent exposure. Breastfeeding may provide some protection in very young infants. Most children develop immunity in the first two to three years of life. As the incidence of rotavirus diarrhea does not differ dramatically between developing and developed countries, it is unlikely that environmental improvements will have a great impact on disease incidence, although mortality due to rotavirus decreases with improved standards of living. Oral rehydration is the treatment of choice and can be life saving, but does not reduce dissemination of the virus. In industrialized countries, experimental oral rotavirus vaccines have shown a protective efficacy of 80% or more against severe disease.

## 2.7. Salmonella

The first strain of *Salmonella* was discovered in 1885. There are now over 2000 known strains. Over the years, antibiotic-resistant strains have developed that are difficult to control, and there is evidence that some of these strains may have emerged owing to the use of antibiotics in intensive animal husbandry. There was a significant rise in incidence and severity in the last two decades of the twentieth century. Some countries in Europe witnessed a 20-fold increase since 1980. Most of these cases were caused by *Salmonella enteritidis* and *Salmonella typhimurium*. Salmonellosis is contracted mainly through the consumption of raw or undercooked contaminated food of animal origin (mainly meat, poultry, eggs, and milk), although many other foods have been implicated in transmission. The disease is usually characterized by acute onset of fever, abdominal pain, diarrhea, nausea, and sometimes vomiting. In some cases, particularly in the very young and the elderly, dehydration can become severe and life threatening. Existing knowledge and technology cannot provide consumers with pathogen-free raw meat and poultry, and it is unlikely that the eradication of *Salmonella* in domestic animals will be possible in the near future. The increased occurrence of drug-resistant pathogens in foods of animal origin emphasizes the need for cooking foods thoroughly before consumption. Education of food handlers is an essential step towards reducing the incidence of food-borne diseases.

## 2.8. Malaria

Malaria exerts its heaviest toll in Africa, where around 90% of the more than one

million deaths from malaria worldwide occur each year. The disease causes at least 300 million cases of acute illness each year, which result in over 3000 deaths per day, mostly among young children in sub-Saharan Africa. Malaria is the leading cause of under-five mortality in Africa, accounting for about 20% of all-cause mortality in this age group. Pregnant women, and especially women in their first pregnancy, are the main adult risk group in most endemic areas. Symptoms include fever, shivering, pain in the joints, headache, repeated vomiting, generalized convulsions, and coma. Severe anemia (exacerbated by malaria) is often the attributable cause of death in areas with intense malaria transmission. If not treated, the disease progresses to the severe form, which can be lethal. Malaria is transmitted by mosquitoes, the number and type of which determine the extent of transmission in a given area. Transmission is affected by climate and geography, and often coincides with the rainy season. Increased risk of the disease is linked with changes in land use resulting from activities such as road building, and irrigation projects. Multiresistant strains of the parasite are emerging, rendering control measures more difficult. In spite of drug resistance, malaria is a curable disease. Disease management through early diagnosis and prompt treatment is fundamental to malaria control. Prevention of malaria encompasses a variety of measures that may protect against infection or against the development of the disease in infected individuals. Measures that protect against infection are directed against the mosquito vector. These can be personal protection measures (protective clothing, repellents, bednets) or community protection measures (use of insecticides or environmental management to control transmission). Measures that protect against disease but not against infection include chemoprophylaxis. Research efforts are concentrating on an effective vaccine.

## **2.9. Measles**

Although great progress has been made in measles prevention thanks to an effective vaccine that became available in the 1960s, measles remains a major cause of childhood mortality in developing countries. There were an estimated 30–40 million cases of measles in 2000, causing some 777 000 deaths. Measles thus accounts for nearly one-half of the 1.7 million annual deaths due to childhood vaccine-preventable diseases.

Measles is one of the most easily transmitted infectious diseases, caused by a virus spread by droplets or direct contact with nose or throat secretions of infected persons. It causes fever and a characteristic red rash, and can lead to serious and fatal complications including pneumonia, diarrhea, and encephalitis. Many children subsequently suffer long-term disability such as deafness, impaired vision, blindness, or neurological damage. In order to achieve global measles elimination, a three-part vaccination strategy has been adopted: (1) catch-up (a one-time, nationwide vaccination campaign targeting usually all children aged 9 months to 14 years, regardless of history of measles disease or vaccination status); (2) keep-up (routine services aimed at vaccinating at least 95% of each successive birth cohort); (3) follow-up (subsequent nationwide vaccination campaigns conducted every two to five years, targeting usually all children born after the catch-up campaign).

## **2.10. Neonatal Tetanus**

Diseases that come from the soil affect several million people annually. The most

deadly of these is neonatal tetanus, which occurs as a result of contamination of the umbilical cord with tetanus spores at birth, caused by unsterile methods of handling or cutting the cord, or dressing it with germ-laden substances such as ash, mud, or animal dung (common practices in many areas of developing countries). Treatment is difficult and generally unsuccessful, and almost all newborn babies affected die. The disease can be prevented by immunizing women of reproductive age (especially pregnant women) with tetanus toxoid, and by ensuring hygienic delivery and cord-care practices. Neonatal tetanus has been targeted for elimination and the estimated global number of neonatal tetanus cases decreased from 510 000 in 1990 to 355 000 in 1997. The number of deaths decreased from 408 000 to 248 000 in the same period.

## 2.11. Tuberculosis

It is estimated that every year two million people die from acute pulmonary tuberculosis (T.B.), and that an additional 365 000 die with T.B. and HIV infection, while eight million become newly infected with *Mycobacterium tuberculosis*, adding to the estimated two billion people worldwide with latent T.B. infection. The poor and marginalized in the developing world are the worst affected: 95% of all cases and 98% of deaths occur in poor countries, while 8 out of 10 of those struck by the disease are in the productive age group 15 to 59. T.B. is transmitted by bacteria spread into the air when a patient with the active disease coughs or sneezes. The main symptoms are severe coughing, sometimes with blood, chest pain, breathlessness, fever, and weight loss. T.B. can spread to affect any organ or tissue in the body. If untreated, each person with active T.B. can infect on average 10 to 15 people each year. The bacteria inhaled by another person multiply in the lungs, but in most people the immune system halts the spread of the infection. It may then lie dormant, only to be reactivated many years later, when progressive lung damage occurs. When the immune system is weakened, the chances of getting sick are greater. HIV multiplies 30-fold the speed at which a T.B.-infected person can develop disease and become infectious. T.B. is the leading cause of death among HIV-positive people, and accounts for one-third of AIDS deaths worldwide. If properly treated, T.B. is curable in virtually all cases, but drug-resistant T.B. is a growing threat worldwide. Incomplete or inappropriate treatment of the disease has led to the development of strains that are resistant to drugs that once destroyed the bacteria in 100% of cases. The WHO-recommended treatment strategy for detection and cure of T.B. is known as directly observed treatment, short-course (DOTS).

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### Biographical Sketch

**Dr. David L. Heymann**, a citizen of the United States of America, is currently the executive director of the World Health Organization (WHO) Communicable Diseases Cluster. He was born in 1946 and is married with three children.

From October 1995 to July 1998, he was director of the WHO Programme on Emerging and Other Communicable Diseases Surveillance and Control. Before becoming director of this programme, he was the chief of research activities in the Global Programme on AIDS. From 1976 to 1989, before joining WHO, he spent 13 years working as a medical epidemiologist in sub-Saharan Africa (Cameroon, Côte d'Ivoire, Malawi, and the former Zaire) on assignment from the U.S. Centers for Disease Control and Prevention (CDC) in CDC-supported activities aimed at strengthening capacity in surveillance of infectious diseases and their control, with special emphasis on the childhood vaccine-preventable diseases, African hemorrhagic fevers, pox viruses, and malaria. While based in Africa, he participated in the investigation of the first outbreak of Ebola in Yambuku (former Zaire) in 1976, then again investigated the second outbreak of Ebola in Tandala. In 1995, he directed the international response to the Ebola outbreak in Kikwit. Before 1976, he spent two years in India as a medical officer in the WHO Smallpox Eradication Programme.

Dr. Heymann holds a B.A. from Pennsylvania State University, an M.D. from Wake Forest University, a master's in tropical medicine from the London School of Hygiene and Tropical Medicine, and has completed practical epidemiology training in the two-year Epidemic Intelligence Service (EIS) training programme of CDC. He has published over 100 scientific articles on infectious diseases in peer-reviewed medical and scientific journals.