NCID
National Center for Infectious Diseases

Technical Notes for Slide Set

for

Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Centers for Disease Control and Prevention
Atlanta, Georgia 30333

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Technical Notes
for
Slide Set

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Addressing Emerging Infectious
Disease Threats:
A Prevention Strategy for the United States

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Cover: electron micrograph of strains of hantavirus that caused the 1993 outbreak of serious respiratory illness in the southwestern United States. Cases of this often fatal infection have now been reported from 26 states.

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Technical Notes for Slide Set

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The Slide Set and Technical Notes for *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States* illustrate the threat of emerging infections and outline CDC's prevention strategy. These slides can be used for stand-alone presentations, as supplements to existing or planned presentations, and as an introduction to a presentation on a specific disease or condition.

Background

Once expected to be eliminated as a public health problem, infectious diseases remain the leading cause of death worldwide and are among the leading causes of illness and death in the United States. Infectious diseases also exact a staggeringly high economic cost from individuals, families, and communities.

Continuing changes in society, technology, and the environment, together with the reduced effectiveness of some approaches to disease control (such as use of antibiotics) are powerful forces. These forces have expanded the spectrum of infectious diseases and increased the incidence of many infectious diseases once thought to be controlled.

In three reports, released from 1987 to 1992, the Institute of Medicine (IOM) documented the need to address emerging infectious disease threats. (The IOM is an independent organization chartered in 1970 by the National Academy of Sciences to provide advice about health and health-related issues to the federal government and other organizations.)

In partnership with representatives from the IOM, state and local health departments, other federal agencies, medical and public health professional associations, and international organizations, the Centers for Disease Control and Prevention (CDC) developed a strategic plan to address emerging infectious diseases threats. The plan, published in April 1994, contains four goals that emphasize surveillance and response, applied research, prevention and control, and public health infrastructure. Plan implementation is being approached in stages, as a long-term endeavor with emphasis on extramural programs. Priority is given to strengthening partnerships between health-care providers, microbiologists, and public health professionals to detect and control emerging infectious diseases.

This slide set and information packet are part of an ongoing effort to educate health policy makers and health professionals about preventing infectious diseases. The set and packet have two purposes: to increase awareness of the need to prevent emerging infectious diseases and to promote support for strengthening the nation's public health infrastructure, which will help us prevent these diseases.

The Technical Notes are intended to provide further explanation for the slides they accompany. A list of Selected Readings follows; these give additional information on the emerging infectious diseases of today and tomorrow.

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Technical Notes

Slide No.

1) ***Addressing Emerging Infectious Disease Threats* (text and photomicrograph)**

   Emerging infectious diseases, including reemerging and drug-resistant infections, pose an increasing threat to the health of the American public. In response to this threat, the Centers for Disease Control and Prevention developed a plan, *Addressing Emerging Infectious Disease Threats*, which is a prevention strategy for the United States. The background of this slide is an image from an electron micrograph of a previously unknown strain of hantavirus (Sin Nombre virus) that caused an outbreak of a frequently fatal respiratory illness in the southwestern United States in 1993.

2) **Deaths by Cause, World-Wide, 1993 (graph)**

   Infectious and parasitic diseases were the leading cause of death worldwide in 1993. According to the World Health Organization, 19.5 million adults and children died of infectious diseases in 1993. This figure underestimates the impact of infectious diseases because conditions in noninfectious categories, such as cancer, can have infectious causes.

3) **Cover of Institute of Medicine report, *Emerging Infections: Microbial Threats to Health in the United States* (photo)**

   In 1992, the Institute of Medicine (IOM) published a report entitled *Emerging Infections: Microbial Threats to Health in the United States*. (The IOM is a branch of the National Academy of Sciences that advises the government on policy matters pertaining to the health of the public.) This report described the ongoing threat to domestic and global health posed by emerging infectious diseases and recommended that CDC lead a national and global effort to detect and control emerging infectious disease threats.

4) **Institute of Medicine Definition of Emerging Infections (text)**

The Institute of Medicine defined emerging infections as “new, reemerging or drug-resistant infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future.”

5) **Major Factors Contributing to the Emergence of Infectious Diseases: I (listing)**

Many factors, or combinations of factors, contribute to disease emergence. Human demographics and behavior play a critical role. For example, changing sexual mores and other high-risk behavior associated with injecting drug use contributed to the spread of the human immunodeficiency virus (HIV) and the AIDS epidemic. Lyme disease was able to spread because as farming was discontinued in the Northeast, forests grew back and deer multiplied. Ticks, who lived off the deer, increased also, and ticks infected with the bacteria *Borrelia burgdorferi* transmitted Lyme disease to people who were exposed through outdoor activities or because they lived in new suburbs built next to the forests. Changes in technology and industry also cause infectious disease to emerge. Organ transplants, made possible by advanced medical technology, require immunosuppression, and immunosuppressed patients are more vulnerable to numerous infectious organisms found in hospitals. Economic development and land use affect not only ecology, but the public’s health. For instance, land development near watershed areas may lead to the contamination of public water supplies, illustrated by the 1993 Milwaukee outbreak of *Cryptosporidium* infection that affected more than 400,000 people. Human ehrlichioses, virtually unknown a decade ago, have become increasingly recognized as people use land areas where infected ticks are found.

6) **Major Factors Contributing to the Emergence of Infectious Diseases: II (listing)**

International travel and commerce have made it possible for pathogens to be quickly transported from one side of the country or globe to the other. New, more virulent, pathogens may appear, such as *Escherichia coli* O157:H7, which in one multi-state outbreak in 1993, was transmitted by contaminated hamburger meat used by a fast-food restaurant chain, causing 700 to become ill and four children to die of kidney disease. Infectious diseases also emerge when existing organisms mutate (change or evolve). Many strains of some bacteria (such as *Streptococcus pneumoniae* and enterococci) are now drug-resistant, and for some infectious agents, only one effective antibiotic is left. The breakdown of public health measures also has contributed to the reemergence of infectious diseases. When mosquito control efforts were discontinued in Latin America, the mosquito vectors of dengue fever increased, and the disease has reappeared in countries where it was believed to have been eliminated. Cases of imported dengue have been reported in the United States, and one of the mosquitoes that transmits it is established in the southern U.S.

7) **Emerging Infections, United States, 1996 (listing)**

In the United States, infectious diseases increasingly threaten public health and contribute significantly to the escalating costs of health care. As society, technology, and the environment change, some pathogens evolve or spread, while others come under control. Well-documented emerging infectious diseases in the United States in 1996 include a wide variety of parasitic, bacterial, and viral diseases. The occurrence of Ebola-Reston virus infection in quarantined nonhuman primates in 1996 demonstrates both the potential for importation of exotic pathogens into the United States and the importance of effective disease-control requirements for the transportation and quarantine of nonhuman primates. The report of an apparently indigenous case of raccoon rabies in Ohio suggests that an epizootic of raccoon rabies in the Mid-Atlantic and eastern states may be spreading westward, despite geographic barriers. The 1996

spring-summer foodborne outbreak of *Cyclospora* infection, transmitted in raspberries shipped from Guatemala, shows that contamination in one part of the world can cause widespread illness in another. The malaria cases that occurred in Georgia and Florida illustrate that a disease supposedly eliminated from the United States can be reintroduced, presenting a potential threat in a localized area. A Tennessee man who went on a fishing trip in the Amazon contracted yellow fever (because he failed to obtain proper immunization) and imported the infection into the United States. Apple juice and cider are increasingly recognized vehicles for transmission of *E. coli* O157:H7, possibly indicating that current methods of production are not adequate to prevent contamination by pathogens.

8) Global Microbial Threats in the 1990s (map)

Since 1991, many new and reemerging infectious disease outbreaks have occurred worldwide. Emerging infections, such as those caused by human immunodeficiency virus (HIV) and hantavirus, illustrate that no nation can be complacent regarding its vulnerability to the new or evolving microorganisms with which we share our planet. In addition, the incidence of many diseases widely believed to be under control, such as cholera, dengue, and yellow fever, has increased in many areas or spread to new regions or populations throughout the world.

9) World Population: Past Estimates and Future Projections (graph)

A growing population and increasing urbanization contribute to emerging infectious disease problems. In many parts of the world, urban population growth has been accompanied by overcrowding, poor hygiene, inadequate sanitation, and unclean drinking water. Urban development has also caused ecologic damage. In these circumstances, certain disease-causing organisms and some of the vectors that transmit them have thrived, making it more likely that people will be infected with new or reemerging pathogens. The existing public health infrastructure is already overtaxed and ill-prepared to deal with new health threats.

10) Primary Causes of Chronic Liver Disease (chart)

Infectious agents may be causing diseases previously considered noninfectious. For example, although alcohol abuse has been well documented as a major cause of chronic liver disease, it is not the only cause. The graph shows the causes of chronic liver disease in residents of Jefferson County, Alabama. Hepatitis B and C viruses contributed to the majority of cases of chronic liver disease in this population.

11) Reported Cases of Lyme Disease in the United States (graph)

Lyme disease was first recognized in the United States in 1975 after a mysterious outbreak of arthritis near Lyme, Connecticut. Subsequently, reports of Lyme disease increased rapidly, and the disease has become the most commonly reported vectorborne infectious disease in the United States. In 1993, Lyme disease was reported from 44 states. Campers, hikers, outdoor workers, and others who frequent wooded, brushy, and grassy places are often bitten by ticks; this exposure is important in the transmission of Lyme disease.

12) Geographic Distribution of Human Ehrlichioses in the United States, 1986-1996 (map)

Human monocytic ehrlichiosis (HME), caused by *Ehrlichia chafeensis*, and human granulocytic ehrlichiosis (HGE), caused by an unnamed *Ehrlichia* species, have been diagnosed in many areas of the United States. In some places, both diseases occur.

13) Clinical Presentation of Human Ehrlichioses (table)

Both *Ehrlichia* species cause an influenza-like syndrome very similar to the signs and symptoms reported with Rocky Mountain spotted fever except for the rare presence of a rash. Thrombocytopenia and elevated liver function tests in conjunction with leukopenia and a history of a tick bite are important distinguishing features for both human ehrlichioses. Patients should be treated promptly with tetracycline or chloramphenicol to avoid severe complications. Case-fatality rates are between 2% and 10%.

14) Etiologic Agents of Ehrlichioses (photomicrographs)

The currently unnamed agent that causes human granulocytic ehrlichiosis (HGE) (left side of photo) is very closely related to *Ehrlichia equi*, which causes a generally self-limited disease in horses, and *E. phagocytophila*, which causes tickborne fever in ruminants in Europe, India, and South Africa. Bacterial inclusions called morulae (arrows) occur within the cytoplasm of neutrophils and occasionally eosinophils. *Ehrlichia chaffeensis*, the etiologic agent of human monocytic ehrlichiosis (HME), primarily invades monocytes/macrophages (right hand side of photo) although organisms have rarely been observed in lymphocytes and neutrophils. Cases of HME are predominantly found in the South and south-central regions where the suspect vector, the Lone Star tick (*Amblyomma americanum*) is present. Cases of HGE have been reported primarily in the Northeast and Midwest regions and are associated with the bite of deer ticks (*Ixodes scapularis*).

15) The Expanding Epizootic of Raccoon Rabies, Eastern United States, 1977-1996 (map)

This slide reflects the spread of raccoon rabies in the Mid-Atlantic and northeastern states from 1977 through 1996. The variant of rabies virus associated with raccoons has been present in the southeastern United States since the 1950s and was introduced into the Mid-Atlantic region of the United States in the mid-1970s, probably as the result of translocation of animals from the southeastern United States. The first such case was reported from West Virginia in 1977. The rapidity of spread throughout the Mid-Atlantic region may reflect the density of raccoon populations associated with abundant food supplies and denning sites in urban and suburban areas. The Mid-Atlantic and southeastern epizootic fronts converged in North Carolina in 1994.

16) Animal Rabies, United States, 1955-1995 (graph)

Despite the potential for increased spillover of infection from greater numbers of rabid wild animals, the proportion of reported cases of rabies in domestic species has declined. This trend may reflect the success of vaccinating dogs and cats and the increased awareness of the risks posed to livestock and other domestic animals as a result of ongoing educational programs in many affected states. Nonetheless, incidents such as the mass treatment of persons exposed to a rabid kitten in a Concord, New Hampshire, pet store during October 1994 serve as a reminder that the cost and threat of rabies are not to be underestimated. This incident resulted in the largest number of persons ever reported to have received rabies postexposure treatment as a result of a point source in the United States, at an overall estimated cost of $1.5 million.

17) Distribution of the *Peromyscus maniculatus* and Location of Hantavirus Pulmonary Syndrome Cases, January 27, 1997 (map)

Hantavirus pulmonary syndrome (HPS) was first detected in the southwestern United States in 1993. HPS has been linked with exposure to infected rodents in 26 states and cases continue to be detected. HPS has now been recognized in Canada and countries in Latin America.

18) Reported Characteristics of 156 Hantavirus Pulmonary Syndrome Patients, United States, January 27, 1997 (listing)

Fatal new diseases can occur in any population group. During the recent outbreak of hantavirus pulmonary syndrome, cases occurred in previously healthy males and females of different races and ages. Most cases have been in young adults.

19) Deer Mouse (photo)

The deer mouse (*Peromyscus maniculatus)* is the major carrier of Sin Nombre virus, which is one of the hantaviruses that causes hantavirus pulmonary syndrome (HPS) in humans. This common North American mammal lives in nearly every dry-land habitat and is often found in homes and other buildings in rural areas. The rodents infected with Sin Nombre virus shed the virus in urine, feces, and saliva. Humans are thought to acquire the infection mainly after exposure to rodent excreta that contain the virus. To date, 156 cases of HPS have been confirmed by CDC. The case-fatality rate is approximately 48%.

20) Isolation Rate for Salmonella Enteritidis by Region, United States, 1974-1994 (graph)

Changing food industry practices, dietary choices of the American people, and increasing global distribution of food supplies bring new challenges to providing a diet safe from pathogens such as *Salmonella*. The isolation rate of S. Enteritidis from 1976 through 1994 has increased in all areas of the country, with sharp increases in the Pacific region since 1993.

21) *E. coli* O157:H7 (chronology)

Commonly consumed food items contaminated with infectious agents place large numbers of persons at risk. Although *Escherichia coli* is a common bacterium that all humans have in their intestines, one strain of *E. coli* called *E. coli* O157:H7 is especially virulent. This slide lists milestones related to *E. coli* O157:H7 infections. In early 1993, hamburgers contaminated with this bacterial strain were served at a fast-food restaurant chain causing a multi-state outbreak of severe bloody diarrhea and serious kidney disease. Over 700 children and adults were affected, and four children died during this outbreak.

22) *Cryptosporidium* (photomicrograph and photo)

Americans are so accustomed to safe, clean, and plentiful water supplies that we think about water only when a problem arises. However, the clear appearance of water does not always indicate its safety as drinking water. Outbreaks of gastrointestinal illness due to contaminated municipal water still occur in the United States. Many of these outbreaks are associated with viral and parasitic infectious agents, such as *Cryptosporidium*, which is shown in a photomicrograph on the left in this slide.

23) Cryptosporidiosis (chronology)

The largest recorded waterborne disease outbreak in our nation's history occurred in Milwaukee, Wisconsin, in April 1993. The disease was cryptosporidiosis, a parasitic infection of the small intestine which can produce severe watery diarrhea. This outbreak of cryptosporidiosis affected over 400,000 people, and more than 4,400 people were hospitalized.

24) Percentage of Nosocomial Enterococci Reported as Resistant to Vancomycin in Intensive Care Units (ICUs) and non-ICUs, by Year, 1989-1994 (graph)

Infections transmitted in hospitals are called nosocomial infections. Enterococci are bacteria found normally in the intestines. In the last several years, the frequency and spectrum of drug-resistant infections have increased in both hospitals and communities. A number of infections, including those caused by enterococci and other intestinal bacteria, pose an immediate danger. Drug-resistant infections pose a particular problem in hospital intensive care units. Vancomycin is the drug of first choice for serious infections in communities where resistance to other drugs has become more common. When resistance develops to vancomycin, these infections may be untreatable.

25) Prevalence of High Level Penicillin Resistance in *Streptococcus pneumoniae*, United States (list)

Streptococcus pneumoniae is the most frequent cause of community-acquired bacterial pneumonia and middle ear infections. It also causes meningitis, sinusitis, bronchitis, and peritonitis, among other infections. For many years, infections caused by pneumococcus could successfully be treated with low doses of penicillin. However, penicillin resistance is now emerging in *Streptococcus pneumoniae*. Some penicillin-resistant strains are also resistant to other drugs, leaving few options for treatment.

26) The Impact of Middle Ear Infections, United States, 1975-1990 (graph)

Middle ear infections can lead to hearing loss and learning disabilities and are the most common childhood illness treated by physicians. In 1990, 24.5 million visits to physicians were prompted by middle ear infections, an increase of 150% over 1975. Drug-resistant bacteria now cause about 1 million ear infections each year. The cost of treating ear infections is estimated at over $1.2 billion for the nation.

27) Reporting of Emerging Infectious Disease Threats (photos)

Recently, the media have given increased coverage to the problem of emerging infectious disease threats, making them a major partner in efforts to increase public awareness and create public support for effective prevention and control measures. While fictionalized accounts of disease outbreaks sometimes portray exaggerated and emotional scenarios, other nonfiction reports of epidemic activity depict situations of grave concern. For example, the problem of antibiotic resistance is very real and growing. Fewer drugs are currently being developed to treat infectious diseases, and our storehouse of effective drugs is diminishing. Some diseases, once curable, have become untreatable, raising the specter of “killer microbes” that cannot be stopped. Insufficient attention has been paid to this problem; comprehensive strategies to prevent and control this threat have not been developed.

28) Number of Organ Transplants, United States, 1982-1994 (graph)

Advances in medical technology have allowed increasing numbers of people to benefit from organ transplants. Organ transplant recipients constitute only one portion of the population of immunosuppressed persons who are at increased risk for emerging infections because of their lowered immunity to disease. Others are immunocompromised because of medications, infectious diseases such as HIV/AIDS, inherited diseases, malnutrition, or simply age--the very young and the very old are more susceptible to a variety of pathogens, such as the influenza virus.

29) Death Rates from Leading Causes of Death in Persons Aged 25-44 Years, USA, 1982-1994 (graph)

Individual behavior, particularly injecting drug use and sexual intercourse, plays a major role in bloodborne disease spread. The epidemic of AIDS, which is caused by the human immunodeficiency virus (HIV), has shown that no nation can be complacent regarding human vulnerability to microorganisms. In 1993, AIDS became the leading cause of death among persons between the ages of 25 and 44 in the United States.

30) Preparing for Emerging Infectious Diseases (quote, Dr. David Satcher)

Public health officials, including Dr. David Satcher, Director of the Centers for Disease Control and Prevention (CDC), have noted that the public health infrastructure of this country is poorly prepared for the emerging disease problems of our rapidly changing world. Current information systems to monitor human and animal infectious diseases domestically and internationally are inadequate to confront the present and future challenges of emerging infections. Many foodborne and waterborne disease outbreaks go unrecognized or are detected late; the magnitude of the problem of

antimicrobial drug resistance is unknown; and global disease surveillance is fragmentary. Dr. Satcher summarizes our critical situation: **“.... our ability to detect, contain, and prevent emerging infectious diseases is in jeopardy.”**

31) *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States* (photos)

The Centers for Disease Control and Prevention collaborated with many partners to develop a prevention strategy addressing the emerging infectious disease threats to public health. An executive summary of this plan was published on April 15, 1994, in CDC’s *Morbidity and Mortality Weekly Report*. Full implementation of the prevention strategy will be critical to ensuring health security for all Americans.

32) Goals of *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States* (listing)

The plan contains four goals that address four major areas of needs for revitalizing our nation’s ability to identify, contain, and prevent illness due to emerging infectious diseases: surveillance and response, applied research, prevention and control, and infrastructure.

33) The CDC Prevention Strategy: Goal I--Surveillance and Response (text)

Detect, promptly investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence. The ability to detect what is new or emerging depends on the capacity to identify and track the routine as well as the unusual. This goal focuses on improving our country’s early warning network and developing more effective international surveillance networks.

34) The CDC Prevention Strategy: Goal II--Applied Research (text)

Integrate laboratory science and epidemiology to optimize public health practice. Advances in diagnostic technologies can be brought into common public health practice. This requires close ties between personnel involved in disease prevention. For example, public health microbiologists have to collaborate with epidemiologists to support efforts to determine the sources of infection, develop interventions to prevent spread and recurrence, implement the interventions successfully, and measure their effectiveness.

35) The CDC Prevention Strategy: Goal III--Prevention and Control (text)

Enhance communication and public health information about emerging diseases and ensure prompt implementation of prevention strategies. Building awareness of emerging infectious diseases requires forming teams of diverse partners from the public and private sectors. More creative methods of communicating public health messages are needed to reach a variety of target audiences. These audiences include such groups as state public health policy makers, physicians in training and in practice, and behavioral scientists and health communicators who are implementing community-based prevention programs.

36) The CDC Prevention Strategy: Goal IV--Infrastructure (text)

Strengthen local, state, and federal public health infrastructures to support surveillance and implement prevention and control programs. State and local health department staff, as well as hospital and university personnel, need training in the diagnosis, surveillance, and control of infectious diseases. Sufficient numbers of skilled personnel and well-equipped physical facilities are essential to maintain control of old disease threats and support prevention of new ones. Public health laboratories represent an area of critical need and crumbling infrastructure. If such laboratories are unable to provide key information in detecting an epidemic, monitoring resistant

and epidemic strains of organisms, and defining the course of the epidemic, then all prevention efforts suffer.

37) Vital Partnerships (listing)

The challenge of emerging infections is broad. An effective response will require the long-term collaborative efforts of many partners, including individuals (especially health care providers), agencies, and organizations.

38) *Emerging Infectious Diseases* Journal (cover photo)

In January 1995, the National Center for Infectious Diseases began publishing a quarterly peer-reviewed journal called *Emerging Infectious Diseases*. The goals of the journal are to promote the recognition of emerging and reemerging infectious diseases and improve the understanding of factors involved in disease emergence, prevention, and elimination. To receive the journal, fill out the card in this packet or contact EID Editor, National Center for Infectious Diseases, CDC, Mailstop C-12, 1600 Clifton Road, Atlanta, GA 30333 (telephone, 404-639-3967; fax, 404-639-3039). If you have Internet access, you can retrieve the journal electronically on the World-Wide Web (WWW), through file transfer protocol (FTP), or by electronic mail (e-mail). You can access the journal at http://www.cdc.gov/ncidod/eid/eid.htm or from the CDC home page at http://www.cdc.gov. You can also download it through anonymous FTP at ftp.cdc.gov. The files can be found in the directory pub/publications/eid. To have the table of contents automatically sent to your e-mail box, subscribe to the EID-TOC mailing list. You can then obtain individual articles on WWW or through FTP, or you can request copies by e-mail. To subscribe to a list, contact lists@list.cdc.gov with the following in the body of your message: subscribe listname (e.g., subscribe EID-TOC).

39) NCID Internet Home Page (photo)

NCID has a home page on the Internet's World-Wide Web (http://www.cdc.gov/ncidod/ncid.htm.). Here readers can find the latest information on new and reemerging infectious diseases in the United States and around the world, in particular, how NCID is supporting surveillance, research, prevention efforts, and training in this area.

40) Summary of need to develop prevention strategies for emerging infectious diseases (quote, Dr. Joshua Lederberg)

In summary:

* Infectious diseases are important, evolving, complex public health problems.
* Prevention and control of infectious diseases will increasingly require application of sophisticated epidemiologic, molecular biologic, behavioral, and statistical approaches and technologies.
* Integration of epidemiologic and laboratory sciences is critical to the prevention and control of infectious diseases.

Joshua Lederberg, a Nobel prize winner in medicine in 1958, was the co-chair of the Institute of Medicine Committee on Emerging Microbial Threats to Health. This quote from Dr. Lederberg in the 1996 *Journal of the American Medical Association* appropriately summarizes the need to develop intervention strategies to prevent emerging infectious disease threats: **"...Pitted against microbial genes, we have mainly our wits."** (JAMA 1996;276:418)

Selected Readings on Emerging Infections

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