

**Preventing Emerging
Infectious Diseases:
A Strategy for the 21st Century**

Overview of the Updated CDC Plan

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention (CDC)
Atlanta, Georgia 30333



The *MMWR* series of publications is published by the Epidemiology Program Office, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30333.

SUGGESTED CITATION

Centers for Disease Control and Prevention. Preventing emerging infectious diseases: a strategy for the 21st century. Overview of the updated CDC plan. *MMWR* 1998;47(No. RR-15):[inclusive page numbers].

Centers for Disease Control and Prevention Claire V. Broome, M.D.
Acting Director

The material in this report was prepared for publication by
National Center for Infectious Diseases..... James M. Hughes, M.D.
Director

The production of this report as an *MMWR* serial publication was coordinated in
Epidemiology Program Office.....Barbara R. Holloway, M.P.H.
Acting Director

Office of Scientific and Health CommunicationsJohn W. Ward, M.D.
Director
Editor, MMWR Series

Recommendations and Reports..... Suzanne M. Hewitt, M.P.A.
Managing Editor

Valerie Johnson
Project Editor

Morie M. Higgins
Peter M. Jenkins

Visual Information Specialists

Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

Copies can be purchased from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325. Telephone: (202) 512-1800.

Contents

Introduction	2
CDC's Plan to Prevent Emerging Infectious Diseases.....	3
Goals And Objectives	5
Target Areas	9
Anticipated Outcomes.....	11
References.....	13

The following CDC staff members prepared this report:

Suzanne Binder, M.D.
 Alexandra M. Levitt, Ph.D.
National Center for Infectious Diseases

and

National Center for Infectious Diseases Plan Steering Committee

Judith R. Aguilar	Alison C. Mawle, Ph.D.
David M. Bell, M.D.	Patrick McConnon, M.P.H.
Martin S. Cetron, M.D.	Martin I. Meltzer, Ph.D.
Mary E. Chamberland, M.D.	Siobhán O'Connor, M.D.
Mark L. Eberhard, Ph.D.	Alan J. Parkinson, Ph.D.
Duane J. Gubler, Sc.D.	Anne Schuchat, M.D.
Meredith A. Hickson, M.P.H.	Steven L. Solomon, M.D.
Jonathan E. Kaplan, M.D.	Robert V. Tauxe, M.D.
Rima F. Khabbaz, M.D.	Fred C. Tenover, Ph.D.
James W. LeDuc, Ph.D.	Theodore F. Tsai, M.D.
Susan A. Maloney, M.D.	Robert B. Wainwright, M.D.
William J. Martin, Ph.D.	

in collaboration with

*National Center for HIV, STD,
 and TB Prevention*
 Helene D. Gayle, M.D., Director

National Immunization Program
 Walter A. Orenstein, M.D., Director

in consultation with

Epidemiology Program Office
 Barbara R. Holloway, M.P.H.,
 Acting Director

Office of Global Health
 Stephen B. Blount, M.D., M.P.H., Director

*National Center for Chronic Disease
 Prevention and Health Promotion*
 James S. Marks, M.D., M.P.H., Director

National Center for Health Statistics
 Edward J. Sondik, Ph.D., Director

*National Institute for Occupational
 Safety and Health*
 Linda Rosenstock, M.D., M.P.H., Director

Public Health Practice Program Office
 Edward L. Baker, M.D., M.P.H., Director

Preventing Emerging Infectious Diseases: A Strategy for the 21st Century

Overview of the Updated CDC Plan

Pathogenic microbes can be resilient, dangerous foes. Although it is impossible to predict their individual emergence in time and place, we can be confident that new microbial diseases will emerge.

— Institute of Medicine, *Emerging Infections: Microbial Threats to Health in the United States*, 1992

Summary

Societal, technological, and environmental factors continue to have a dramatic effect on infectious diseases worldwide, facilitating the emergence of new diseases and the reemergence of old ones, sometimes in drug-resistant forms. Modern demographic and ecologic conditions that favor the spread of infectious diseases include rapid population growth; increasing poverty and urban migration; more frequent movement across international boundaries by tourists, workers, immigrants, and refugees; alterations in the habitats of animals and arthropods that transmit disease; increasing numbers of persons with impaired host defenses; and changes in the way that food is processed and distributed.

*Several recent health events underscore the need for a public health system ready to address whatever disease problems that might arise. For example, in 1997, an avian strain of influenza that had never before infected humans began to kill previously healthy persons in Hong Kong, and strains of *Staphylococcus aureus* with diminished susceptibility to the antibiotic vancomycin were reported in Japan and the United States. In addition, researchers recently discovered that a strain of the virus that causes acquired immunodeficiency syndrome (AIDS) had been infecting humans for at least 20 years before AIDS emerged as a worldwide epidemic.*

*Preventing Emerging Infectious Diseases: A Strategy for the 21st Century describes CDC's plan to combat today's infectious diseases and prevent those of tomorrow. It represents the second phase of the effort launched in 1994 with the publication of CDC's *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States*. This overview of the updated plan outlines specific objectives under four major goals: a) surveillance and response, b) applied research, c) infrastructure and training, and d) prevention and control. Achieving these objectives will enhance understanding of infectious diseases and bolster their detection, control, and prevention. The plan also targets nine categories of problems that cause human suffering and place a burden on society. The aim of this plan is to build a stronger, more flexible U.S. public health system that is well-prepared to respond to known disease problems, as well as to address the unexpected, whether it be an influenza pandemic, a disease caused by an unknown organism, or a bioterrorist attack. The implementation of this plan will require the dedicated efforts of many partners, including state and local health departments, other federal agencies, professional societies, universities, research institutes, health-care providers and organizations, the World*

Health Organization, and many other domestic and international organizations and groups.

INTRODUCTION

Infectious diseases are a continuing threat to all persons, regardless of age, sex, lifestyle, ethnic background, and socioeconomic status (1). They cause suffering and death and impose a financial burden on society (Table 1) (2–12). Although some diseases have been conquered by modern advances such as antibiotics and vaccines, new ones are constantly emerging (e.g., human immunodeficiency virus and acquired immunodeficiency syndrome [HIV/AIDS], Lyme disease, and hantavirus pulmonary syndrome), whereas others reemerge in drug-resistant forms (e.g., malaria, tuberculosis, and bacterial pneumonias).

Because no one knows what new diseases will emerge, the public health system must be prepared for the unexpected. For example, in 1997, an avian strain of influenza that had never before attacked humans began to kill previously healthy persons in Hong Kong (13). This crisis raised the specter of an influenza pandemic similar to the one that killed 20 million persons in 1918. Also in 1997, strains of *Staphylococcus*

TABLE 1. Annual national costs and charges* associated with some infectious diseases — United States, selected years (1991–1993)

Disease	Annual cost	Type of cost
Acquired immunodeficiency syndrome (2)	\$5.8 billion	Direct medical charges, (1993 dollars)
Tuberculosis (3)	\$703 million	Direct medical charges, (1991 dollars)
Nosocomial infections (acquired in hospital) (4)	\$4.5 billion	Hospital charges (1992 dollars)
Foodborne bacteria (5)	\$2.9–\$6.7 billion [†]	Direct and indirect costs (1993 dollars)
Human papillomavirus (6–10)	\$1.23 billion [§]	Direct medical charges (1991 dollars)
Neonatal group B streptococcal infections (11)	\$294 million	Direct medical charges (1993 dollars)
Bacterial vaginosis (12)	\$1.0 billion	Direct medical charges (1993 dollars)

* Costs are actual economic costs whereas charges reflect the amount charged by a health-care provider.

[†] This range is for the combined direct and indirect costs associated with foodborne illnesses caused by six pathogens: *Campylobacter jejuni* or *Campylobacter coli*; *Clostridium perfringens*; *Escherichia coli* O157:H7; *Listeria monocytogenes*; *Salmonella* (nontyphoid); and *Staphylococcus aureus*.

[§] Preliminary estimates are based on the fact that human papillomavirus causes 82% of all cervical cancers (6–8); thus, charges were calculated by assuming that 82% of the following treatment charges are attributable to human papillomavirus: follow-up of precancerous lesions identified by Pap smear (1 million follow-up visits costing \$1,100 each for a total of \$1.1 billion) (6–10), treatment of carcinoma in situ (55,000 treatments costing \$4,360 each, for a total of \$0.2 billion) (6–9), and treatment of cervical cancer (15,800 treatments costing \$11,300 each, for a total of \$0.2 billion) (6–10). These estimates do not include indirect costs attributable to lost productivity or the cost of screening for cervical cancer.

aureus with diminished susceptibility to vancomycin were reported in Japan and the United States (14). If drugs like vancomycin cannot be replaced as they lose their effectiveness — or if the emergence and spread of drug resistance cannot be limited — some diseases might become untreatable, as they were in the preantibiotic era. In addition, the recent discovery that a strain of the virus that causes HIV/AIDS has been infecting humans at least since 1959 (15) illustrates how infectious agents can remain undetected for years before emerging as public health problems. Each of these incidents underscores the need for a public health infrastructure that is ready to address whatever disease problems that might arise.

Preventing Emerging Infectious Diseases: A Strategy for the 21st Century (16) describes steps that can be taken to move toward realizing CDC's vision of a world in which individuals, communities, and nations join in a common effort to combat today's emerging infectious diseases and prevent those of tomorrow. Copies of the plan will be available from the Office of Health Communication, National Center for Infectious Diseases (NCID), Centers for Disease Control and Prevention, Mail Stop C-14, 1600 Clifton Road, Atlanta, GA 30333. The plan also can be accessed from the NCID home page at <<http://www.cdc.gov/ncidod/publicat.htm>>.

CDC's PLAN TO PREVENT EMERGING INFECTIOUS DISEASES

Preventing Emerging Infectious Diseases: A Strategy for the 21st Century represents the second phase of CDC's plan to revitalize the country's capacity to protect the public from infectious diseases, an effort that was launched in 1994 with the publication of *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States* (17). During the past 4 years, CDC has implemented the 1994 plan incrementally, with the help of many partners. By fiscal year 1997, funds were available to implement about one third of the recommended programs and activities, which focused on improving surveillance, conducting applied research, rebuilding the public health infrastructure, and strengthening efforts to prevent emerging infectious diseases.

CDC decided to update its plan in 1998 because of recent developments (see page 4, Events Prompting CDC to Update the 1994 Plan [18–31]) and because of the need to build on achievements from implementing the 1994 plan (see Appendix to the 1998 plan [16]). *Preventing Emerging Infectious Diseases: A Strategy for the 21st Century* takes into account the new discoveries and challenges of the past 4 years and builds on the experience, accomplishments, and knowledge gained from implementing the 1994 plan.

Persons from approximately 50 organizations contributed to the development of the updated plan; they and many other partners will be essential to the plan's implementation. CDC will implement the plan in coordination with state and local health departments (e.g., on surveillance of infectious diseases), academic centers and other federal agencies (e.g., on research agendas), health-care providers and organizations (e.g., on development and dissemination of guidelines), international organizations (e.g., on outbreak responses overseas), and many other partners.

Events Prompting CDC to Update the 1994 Plan

CDC decided to update its strategy for addressing emerging infectious diseases because of progress in implementing the highest priorities in the 1994 plan as well as several recent developments:

Emerging Threats

- A new variant of a fatal neurologic illness, Creutzfeldt-Jakob disease, appeared in the United Kingdom and was possibly transmitted by ingestion of beef from animals afflicted with bovine spongiform encephalopathy, also known as "mad cow disease." This disease might be caused by a newly recognized type of transmissible agent called a prion (18).
- A new and virulent strain of influenza in Hong Kong raised fears of a global pandemic (13).
- The United States had several multistate foodborne outbreaks, including outbreaks caused by *Cyclospora* parasites on fresh raspberries (19); hepatitis A virus on frozen strawberries (20); and *Escherichia coli* O157:H7 bacteria in apple cider, lettuce, alfalfa sprouts, and ground beef (21–22).
- *Staphylococcus aureus* with reduced susceptibility to vancomycin — the only antibiotic that remains effective against some strains of this bacterium — was reported for the first time in the United States and Japan (14).
- A new strain of tuberculosis (strain W), which is multidrug-resistant and appears more frequently in persons with HIV infection, has become endemic in New York (23).

Scientific Findings

- Scientists have found increasing evidence that certain infectious microbes cause or contribute to the development of some chronic diseases (24).
- Many human genes have been discovered that influence a person's susceptibility to infection, severity of infection, and responsiveness to vaccination or treatment (25).

Tools and Technologies

- Electronic communications are linking public health institutions in most areas of the world, providing a constant and enormous stream of information on infectious disease outbreaks and related health issues.
- Innovations in biotechnology are making it easier to identify and track strains of infectious microbes and to determine the causes and sources of outbreaks as well as the routes of disease transmission.

Changes in Health-Care Delivery

- Large numbers of Americans have switched from fee-for-service medical insurance to various types of managed care. The shift to managed care has created new challenges and opportunities for disease prevention, surveillance, control, and research. Because of their structures, managed care organizations are in a good position to conduct surveillance, answer clinical research questions, and effect changes in medical practice (e.g., implementation of guidelines).

Events Prompting CDC to Update the 1994 Plan — Continued

- Shortened hospital stays for some conditions have made it necessary to develop new ways to monitor certain patient outcomes, including hospital-acquired infections whose symptoms do not appear until after the patient has left the hospital.
- Home health care has become the fastest growing sector of the U.S. health-care industry (26). New public health partnerships and new methods for assessment are needed to monitor the impact of treatments and to measure the occurrence of health-care-related infections in home health-care settings.

Public and Policy Issues

- Many Americans have learned about new diseases like Ebola hemorrhagic fever through media reports, films and television movies, and books (27–29). In addition, they might know somebody who has suffered from an emerging infectious disease or an antibiotic-resistant infection.
- In 1995, a policy report issued by the Committee on International Science, Engineering, and Technology (CISSET) of the National Science and Technology Council recommended governmentwide action to combat emerging infectious diseases (30).
- In 1996, a Presidential Decision Directive on emerging infectious diseases established a new national policy to address the growing health and national security threat posed by infectious diseases, including the potential threat of bioterrorism (31).

Goals and Objectives

The objectives of Preventing Emerging Infectious Diseases: A Strategy for the 21st Century are organized under four goals: surveillance and response, applied research, infrastructure and training, and prevention and control. Under each objective, the plan describes in detail the many public health activities that must be conducted to implement CDC's strategy.

Goal I — Surveillance and Response. Detect, investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence, and respond to problems as they are identified.

Objectives

- Strengthen infectious disease surveillance and response. For example, this objective includes expanding and creating programs, networks, and surveillance systems that enable health departments nationwide to identify and respond to infectious disease threats.
- Improve methods for gathering and evaluating surveillance data.
- Ensure the use of surveillance data to improve public health practice and medical treatment.
- Strengthen global capacity to monitor and respond to emerging infectious diseases.

The objectives and activities of Goal I reflect recent changes in needs and capabilities for surveillance and response. For instance, outbreaks of foodborne illness used to be primarily local events that were easily recognized. Now, however, outbreaks often involve persons scattered over wide geographic areas — the consequence of regional, national, or international distribution of food products. In recent years, through various coordinated efforts including the 1997 National Food Safety Initiative, the U.S. Food and Drug Administration, U.S. Department of Agriculture, CDC, and other agencies have begun to enhance national capacity to track and respond to foodborne illnesses across the country. In mid-1998, the Secretary of Health and Human Services announced PulseNet — a national network of laboratories that perform DNA fingerprinting of bacteria isolated from patients and contaminated food. The network permits rapid comparison of molecular fingerprint patterns through an electronic database at CDC. When patterns submitted from different sites are identical, the computer alerts health agencies to a possible widespread outbreak of foodborne illness (see page 7, Pulsed-Field Gel Electrophoresis Patterns of *Escherichia coli* O157:H7 Isolates — Washington State, 1996). During the next several years, CDC will continue to develop PulseNet in partnership with state health departments and the Association of Public Health Laboratories, increasing the number of participating laboratories and the number of organisms covered.

PulseNet demonstrates how CDC and its partners can use modern laboratory techniques and electronic communications to strengthen disease surveillance and response. The objectives and activities described under Goal I address the need for a strong and coordinated system for surveillance and response in the United States and abroad, not only for foodborne diseases but for other emerging infectious diseases as well. They call for increased links among surveillance sites, improved tools and approaches for conducting surveillance, as well as prompt and effective translation of surveillance data into public health action.

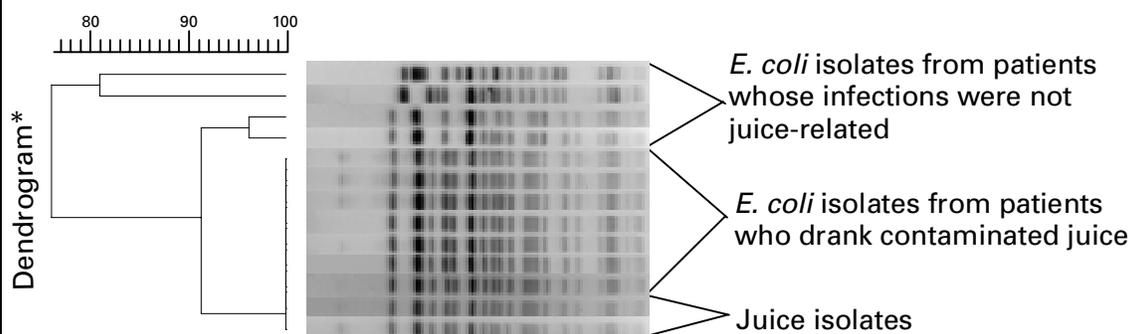
Goal II — Applied Research. Integrate laboratory science and epidemiology to optimize public health practice.

Objectives

- Develop, evaluate, and disseminate tools for identifying and understanding emerging infectious diseases.
- Identify the behaviors, environments, and host factors that put persons at increased risk for infectious diseases and their sequelae.
- Conduct research to develop and evaluate prevention and control strategies in nine target areas (see Target Areas).

Research is essential in efforts to understand, prevent, control, and respond to new and reemerging infectious diseases. Much of CDC's emerging infectious disease research is laboratory-based or epidemiologic, often performed in response to an emergency such as an outbreak of disease. In addition, CDC conducts studies in nonoutbreak settings to evaluate prevention strategies and identify factors that put persons at increased risk.

Pulsed-Field Gel Electrophoresis Patterns of *Escherichia coli* O157:H7 Isolates — Washington State, 1996



This illustration shows the relationships among DNA fingerprints of *Escherichia coli* O157:H7 isolates from Washington State. Patterns of the two isolates from apple juice are identical to patterns of isolates from patients who drank the contaminated juice but different from patterns of isolates from patients whose infections were not juice-related. This technology, known as pulsed-field gel electrophoresis (PFGE), has been useful in the investigation of many outbreaks of foodborne illnesses, especially those that involve clusters of cases that are too geographically or temporally scattered to come to public health attention through usual methods of surveillance. For example, in 1997, the Colorado Department of Public Health and Environment used PFGE to detect a small cluster of cases of *E. coli* O157:H7 infection. Each ill person had eaten the same brand of frozen hamburger patty. Twenty-five million pounds of ground beef were recalled, and a potentially nationwide outbreak was averted.

*Vertical line at 100% represents isolates that are indistinguishable from each other. Lines farther away from 100% on the dendrogram represent isolates that are similar to the outbreak isolates but are not a perfect match.

For example, between 1993 and 1995, in partnership with several other organizations, CDC conducted Project Respect — a randomized trial of alternative approaches to counseling persons who visit medical clinics about how to prevent HIV and other sexually transmitted diseases (STDs). One group received simple educational messages, and the other received intensive counseling that focused on the client's personal situation. After 6 months, persons who received client-centered counseling were substantially more likely to use condoms 100% of the time and had substantially fewer new STDs (32). At 12 months, rates of condom use were similar in the two groups, but the reduced rate of new STDs persisted among persons who received client-centered counseling. CDC and other Project Respect investigators are translating these research findings into prevention programs that can be delivered in other clinical settings. Project Respect is an example of the type of prevention research efforts that will be conducted under Goal II.

Goal III — Infrastructure and Training. Strengthen public health infrastructures to support surveillance and research and to implement prevention and control programs.

Objectives

- Enhance epidemiologic and laboratory capacity.
- Improve CDC's ability to communicate electronically with state and local health departments, U.S. quarantine stations, health-care professionals, and others.
- Enhance the nation's capacity to respond to complex infectious disease threats in the United States and internationally, including outbreaks that may result from bioterrorism.
- Provide training opportunities in infectious disease epidemiology and diagnosis in the United States and throughout the world.

The public health infrastructure is the underlying foundation that supports the planning, delivery, and evaluation of public health activities and practices. For example, a strong public health infrastructure is needed to ensure that the public is safe from vaccine-preventable diseases like polio, measles, and diphtheria, as well as rubella, an acute viral infection that can cause severe birth defects in babies born to infected mothers. Although no major epidemics of childhood rubella have occurred in the United States since the introduction of rubella vaccine in 1969 (33), rubella cases have increased recently among adults, particularly among persons who come from countries without rubella vaccination programs (34). This increase places susceptible pregnant women and their fetuses at risk (34).

The North Carolina Department of Environment, Health, and Natural Resources' handling of a 1997 rubella outbreak exemplifies the kinds of activities called for under Goal III. The outbreak, which affected nine of the state's counties, occurred shortly after a rubella surveillance system had been established, and the outbreak was detected early. Health workers visited the homes and workplaces of infected persons and vaccinated friends of patients, family members, and fellow employees. Pregnant women who potentially were exposed received medical follow-up. The outbreak was contained, and no cases of congenital rubella syndrome were reported. North Carolina's rubella surveillance system was established with funding from CDC, which since 1994 has provided grants to state and large city health departments for establishing systems to monitor and track vaccine-preventable diseases.

The objectives and activities described under Goal III will help ensure that in future years state and local health departments have the equipment, staff, and training to respond to emerging infectious disease threats in the United States, whether they be outbreaks of rubella, drug-resistant microbes, or acts of bioterrorism. Because microbes can cover wide geographic areas and span borders between nations, the objectives and activities of Goal III also address the need to help build global infrastructure to combat emerging infectious diseases.

Goal IV — Prevention and Control. Ensure prompt implementation of prevention strategies and enhance communication of public health information about emerging diseases.

Objectives

- Implement, support, and evaluate programs for the prevention and control of emerging infectious diseases.
- Develop, evaluate, and promote strategies to help health-care providers and other persons change behaviors that facilitate disease transmission.
- Support and promote disease control and prevention internationally.

All of the goals and objectives in this plan ultimately are directed at preventing and controlling infectious diseases. For example, a national effort to prevent the transmission of group B streptococcal infection to newborns is based on ongoing disease surveillance (Goal I), multidisciplinary research (Goal II), and strong local public health infrastructures (Goal III).

One of five women carries group B streptococcal bacteria, although the infections are usually asymptomatic (35,36). When transmitted from an infected pregnant woman to her newborn during childbirth, however, the bacteria can cause severe health problems for the baby and even result in death (37). Although studies in the 1980s documented that administering antibiotics during childbirth to women at high risk could prevent group B streptococcal infection in newborns (36), a study completed in 1990 determined that thousands of U.S. babies continued to be infected each year, primarily because antibiotics were not always administered when needed (37). CDC has responded to this problem by working with public and private organizations to develop and distribute new recommendations for disease prevention (36). Between 1993 and 1995, as obstetricians adopted the new policies, the incidence of neonatal group B streptococcal infections declined by as much as 43% in some areas (38) and continued to decline through 1997 (personal communication, Anne Schuchat, M.D., CDC, 1998). CDC is continuing to work with community groups, health departments, and professional organizations to bring standardized prevention protocols to a wider audience (39).

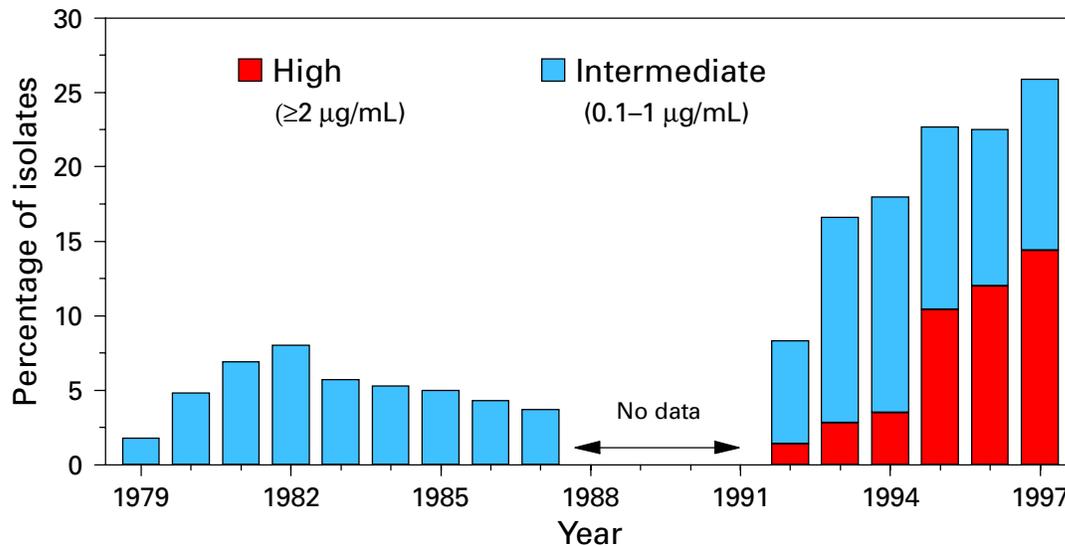
As demonstrated by this example, preventing and controlling emerging infectious diseases requires the combined and coordinated work of many persons and organizations. The objectives and activities in Goal IV emphasize the need for strong partnerships to address emerging infectious disease problems.

Target Areas

To accomplish these goals, objectives, and activities, *Preventing Emerging Infectious Diseases: A Strategy for the 21st Century* targets nine categories of problems that cause human suffering and place a burden on society:

- **Antimicrobial resistance.** The emergence of drug resistance in bacteria, parasites, viruses, and fungi is reversing advances of the previous 50 years (Figure 1). As the 21st century approaches, many important drug choices for the treatment

FIGURE 1. High and intermediate levels of penicillin resistance in *Streptococcus pneumoniae* — United States, 1979–1997*



Sources: 1979–1987 and 1992–1994, CDC Sentinel Surveillance Network; 1995–1997, CDC Active Bacterial Core Surveillance (ABCS) System.

*During the 1980s, more than 90% of *Streptococcus pneumoniae* isolates in the United States were sensitive to penicillin, and high-level resistance to penicillin was not observed. By 1997, however, one in four isolates exhibited some degree of resistance to penicillin; one in seven isolates exhibited high-level resistance.

of common infections are becoming increasingly limited, expensive, and, in some cases, nonexistent.

- **Foodborne and waterborne diseases.** Changes in the ways that food is processed and distributed are causing more multistate outbreaks of foodborne infections. In addition, a new group of waterborne pathogens has emerged that is unaffected by routine disinfection methods.
- **Vectorborne and zoonotic diseases.** Many emerging or reemerging diseases are acquired from animals or are transmitted by arthropods. Environmental changes can affect the incidence of these diseases by altering the habitats of disease vectors.
- **Diseases transmitted through blood transfusions or blood products.** Improvements in blood donor screening, serologic testing, and transfusion practices have made the U.S. blood supply one of the safest in the world, despite its size and complexity. However, because blood is a human tissue, it is a natural vehicle for transmitting infectious agents. Therefore, continued vigilance is needed to ensure the safety of the U.S. blood supply.
- **Chronic diseases caused by infectious agents.** Several chronic diseases once attributed to lifestyle or environmental factors (e.g., some forms of cancer, heart

disease, and ulcers) might be caused or intensified by infectious agents (24). This new knowledge raises the possibility that certain chronic diseases might someday be treated with antimicrobial drugs or prevented by vaccines.

- **Vaccine development and use.** Certain childhood diseases (e.g., diphtheria, tetanus, polio, measles, mumps, rubella, and *Haemophilus influenzae* type b disease) have been virtually eliminated in the United States through universal vaccination. However, additional vaccines are needed to prevent diseases that are a societal burden in the United States or internationally (e.g., HIV/AIDS, dengue fever, hepatitis C, and malaria).
- **Diseases of persons with impaired host defenses.** Persons whose normal host defenses against infection have been impaired by illness, by medical treatment, or as a result of age are more likely to become ill with various infectious diseases. Infections that occur with increased frequency or severity in such persons are called opportunistic infections. Health-care providers and scientists must be ready to identify and investigate each new opportunistic infection as it appears, and to learn how to diagnose, treat, control, and prevent it.
- **Diseases of pregnant women and newborns.** Certain asymptomatic infections in a pregnant woman can increase her infant's risk of prematurity, low birth weight, long-term disability, or death. In addition, infections can be transmitted from mother to child during pregnancy, delivery, or breast-feeding. Effective and accessible prenatal care is essential to the prevention of infection in pregnant women and newborn babies.
- **Diseases of travelers, immigrants, and refugees.** Persons who cross international boundaries (e.g., tourists, workers, immigrants, and refugees) are at increased risk for contracting infectious diseases and can also disseminate diseases to new places. International air travel has increased substantially in recent years, and more travelers are visiting remote locations where they can be exposed to infectious agents that are uncommon in their native countries.

ANTICIPATED OUTCOMES

Achievement of the objectives described in this plan will improve understanding of infectious diseases and bolster their detection, control, and prevention. The goal of this plan is a stronger, more flexible U.S. public health system that is well prepared to respond to known disease problems and to address the emergence of new infectious pathogens. Implementation of this plan will produce the following results:

- A nationwide network for surveillance and response will ensure the prompt identification of emerging infectious diseases. State and local health departments will have the equipment and trained personnel needed to provide the front-line public health response to infectious disease threats.
- Intensive population-based surveillance and research programs in at least 10 areas of the United States will generate data to identify new threats to public health and help guide responses to emerging infectious diseases.

- State health departments will rapidly detect and investigate outbreaks of food-borne illnesses by using sophisticated epidemiologic and laboratory techniques. Early detection will facilitate the rapid implementation of control measures and the prevention of illness and death.
- Countries in all regions of the world will participate in a global system for surveillance and response that includes surveillance for infectious agents that are resistant to antimicrobial drugs. This effort will be undertaken in partnership with the World Health Organization and other organizations and agencies around the world.
- Enhancement of the public health infrastructure will help prepare the United States to respond to bioterrorist incidents.
- Improved diagnostic testing methods will be developed for new, reemerging, and drug-resistant pathogens.
- A better understanding of risk factors for the development of infection and disease will provide new opportunities for disease prevention.
- A better understanding of relationships between infectious agents and some chronic diseases will lead to new strategies for preventing and treating chronic diseases.
- New strategies will be designed to reduce insect vector populations and control animal populations that serve as reservoirs for human diseases.
- Diagnostic and reference reagents will be available for use by public health laboratories. CDC will have enhanced capacity to serve as the national reference center for diagnosis of infectious diseases and for drug-resistance testing.
- The next generation of epidemiologists and laboratorians will be trained and prepared to respond to emerging infectious disease threats.
- Implementation of prevention guidelines will result in decreased death and disability caused by nosocomial infections, opportunistic infections, antimicrobial resistance, and infections in newborns.
- Cooperative efforts among managed care organizations, health-care facilities, state and local health departments, and CDC will improve treatment and prevention of infectious diseases.
- Deaths from vaccine-preventable diseases will be substantially reduced in the United States and abroad.
- Community-based demonstration programs will help identify cost-effective approaches to addressing emerging infectious disease problems.

References

1. Institute of Medicine. Emerging infections: microbial threats to health in the United States. Washington, DC: National Academy Press, 1992.
2. Farnham PG. Defining and measuring the costs of the HIV epidemic to business firms. *Public Health Rep* 1994;109:311–8.
3. Brown RE, Miller B, Taylor WR, et al. Health-care expenditures for tuberculosis in the United States. *Arch Intern Med* 1995;155:1595–1600.
4. Martone WJ, Jarvis WR, Culver DH, Haley RW. Incidence and nature of endemic and epidemic nosocomial infections. In Bennett JV, Brachman PS, eds. *Hospital infections*. Third edition. Boston, MA: Little, Brown and Company, 1992.
5. Buzby JC, Roberts T, Lin C-TJ, MacDonald JM. Bacterial foodborne disease: medical costs and productivity losses. Agricultural economic report No. 741. Washington, DC: U.S. Department of Agriculture, Food and Consumer Economics Division, Economic Research Service, 1996.
6. Schiffman MH, Brinton LA, Devesa SS, Fraumeni JF Jr. Cervical cancer. In Schottenfeld D, Fraumeni JF Jr., eds. *Cancer epidemiology and prevention*. Second edition. New York, NY: Oxford University Press, 1996.
7. Pisani P, Parkin DM, Munoz N, Ferlay J. Cancer and infection: estimates of the attributable fraction in 1990. *Cancer Epidemiol Biomarkers Prevent* 1997;6:387–400.
8. Roland PY, Naumann RW, Alvarez RD, Kilgore LC, Partridge EE. A decision analysis of practice patterns used in evaluating and treating abnormal Pap smears. *Gynecol Oncol* 1995;59:75–80.
9. Jones HW. Impact of the Bethesda System. *Cancer* 1995;76:1914–8.
10. Fahs MC, Mandelblatt J, Schechter C, Muller C. Cost effectiveness of cervical cancer screening for the elderly. *Ann Intern Med* 1992;117:520–7.
11. Mohle-Boetani JC, Schuchat A, Plikaytis BD, Smith JD, Broome CV. Comparison of prevention strategies for neonatal group B streptococcal infection: a population-based economic analysis. *JAMA* 1993;270:1442–8.
12. Oleen-Burkey MA, Hillier SL. Pregnancy complications associated with bacterial vaginosis and their estimated costs. *Infect Dis Obstet Gynecol* 1995;3:149–57.
13. CDC. Isolation of avian influenza A(H5N1) viruses from humans — Hong Kong, May–December 1997. *MMWR* 1997;46:1204–7.
14. CDC. Staphylococcus aureus with reduced susceptibility to vancomycin — United States, 1997. *MMWR* 1997;46:765–6 [see also erratum in *MMWR* 1997;46:851].
15. Zhu T, Korber B, Nahmias AJ, Hooper E, Sharp PM, Ho DD. An African HIV-1 sequence from 1959 and implications for the origin of the epidemic. *Nature* 1998;391:594–7.
16. CDC. Preventing emerging infectious diseases: a strategy for the 21st century. Atlanta, GA: CDC, in press.
17. CDC. Addressing emerging infectious disease threats: a prevention strategy for the United States. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, 1994.
18. Prusiner SB. Prions. In Fields BN, Knipe DM, Howley PM, et al., eds. *Virology*. Third edition. Philadelphia, PA: Lippincott-Raven, 1996.
19. Herwaldt BL, Ackers ML. An outbreak in 1996 of cyclosporiasis associated with imported raspberries. The Cyclospora Working Group. *N Engl J. Med* 1997;336:1548–56.
20. CDC. Hepatitis A associated with consumption of frozen strawberries — Michigan, March 1997. *MMWR* 1997;46:288, 295.
21. CDC. Outbreaks of Escherichia coli O157:H7 infection and cryptosporidiosis associated with drinking unpasteurized apple cider — Connecticut and New York, October 1996. *MMWR* 1997;46:4–8.
22. CDC. Outbreaks of Escherichia coli O157:H7 infection associated with eating alfalfa sprouts — Michigan and Virginia, June–July 1997. *MMWR* 1997;46:741–4.
23. Frieden TR, Sherman LF, Maw KL, et al. A multi-institutional outbreak of highly drug-resistant tuberculosis: epidemiology and clinical outcomes. *JAMA* 1996;276:1229–35.
24. Fredericks DN, Relman DA. Sequence-based identification of microbial pathogens: a reconsideration of Koch's postulates. *Clin Microbiol Rev* 1996;9:18–33.
25. Hill AV. Genetics of infectious disease resistance. *Curr Opin Genet Dev* 1996;6:348–53.

26. Garret DO, Jarvis WR. The expanding role of healthcare epidemiology — home and long-term care. *Infect Control Hosp Epidemiol* 1996;17:714–7.
27. Preston R. *The hot zone*. New York, NY: Random House, 1994.
28. Garrett L. *The coming plague: newly emerging diseases in a world out of balance*. New York, NY: Farrar, Straus, and Giroux, 1995.
29. Peters CJ, Olshaker M. *Virus hunter: thirty years of battling hot viruses around the world*. New York, NY: Bantam, Doubleday, Dell, 1997.
30. Working Group on Emerging and Re-emerging Infectious Diseases, Committee on International Science, Engineering, and Technology, National Science and Technology Council. *Infectious disease — a global health threat*. Washington, DC: U.S. Government Printing Office, 1995.
31. Office of Science and Technology Policy, the White House. *Fact sheet: addressing the threat of emerging infectious diseases*. Washington, DC: The White House, June 12, 1996.
32. Kamb ML, Bolan G, Zenilman J, et al. Does HIV/STD prevention counseling work? Results from a multi-center randomized trial (Project Respect). Presented at the 12th meeting of the International Society of Sexually Transmitted Diseases Research, October 19–22, 1997, Seville, Spain.
33. CDC. Rubella and congenital rubella syndrome — United States, 1994–1997. *MMWR* 1997; 46:350–4.
34. CDC. Rubella and congenital rubella syndrome — United States, January 1, 1991–May 7, 1994. *MMWR* 1994;43:391–401.
35. Baker CJ, Edwards MS. Group B streptococcal infections. In Remington JS, Klein JO, eds. *Infectious diseases of the fetus and newborn infant*. 4th ed. Philadelphia, PA: WB Saunders, 1995:980–1054.
36. CDC. Prevention of perinatal group B streptococcal disease: a public health perspective. *MMWR* 1996;45(No. RR-7):1–24.
37. Zangwill KM, Schuchat A, Wenger JD. Group B streptococcal disease in the United States, 1990: report from a multistate active surveillance system. *MMWR* 1992;41(No. SS-6):25–32.
38. CDC. Decreasing incidence of perinatal group B streptococcal disease — United States, 1993–1995. *MMWR* 1997;46:473–7.
39. CDC. Adoption of hospital policies for prevention of perinatal group B streptococcal disease — United States, 1997. *MMWR* 1998;47:665–70.

MMWR

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format and on a paid subscription basis for paper copy. To receive an electronic copy on Friday of each week, send an e-mail message to listserv@listserv.cdc.gov. The body content should read *SUBscribe mmwr-toc*. Electronic copy also is available from CDC's World-Wide Web server at <http://www.cdc.gov/> or from CDC's file transfer protocol server at <ftp.cdc.gov>. To subscribe for paper copy, contact Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; telephone (202) 512-1800.

Data in the weekly *MMWR* are provisional, based on weekly reports to CDC by state health departments. The reporting week concludes at close of business on Friday; compiled data on a national basis are officially released to the public on the following Friday. Address inquiries about the *MMWR* Series, including material to be considered for publication, to: Editor, *MMWR* Series, Mailstop C-08, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30333; telephone (888) 232-3228.

All material in the *MMWR* Series is in the public domain and may be used and reprinted without permission; citation as to source, however, is appreciated.