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b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
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National Immunization Program

Vaccines and Autism: No Known Relationship

The following information is being provided to help address concerns recently expressed in press reports about a possible association between developmental disorders such as autism and vaccines.

1. What is Autism?

Autism is a chronic developmental disorder. The main characteristics of autism are problems in social interaction, communication, and restrictive and repetitive interests and activities.

Autism may be initially noted in infancy as impaired attachment, but it is most often first identified in toddlers, mostly boys, from 18 to 30 months of age. Boys are 3 to 4 times more likely to be afflicted with autism than girls. Girls as a group, however, may be more severely affected. Correct diagnosis of autism depends on an accurate developmental history focused on types of behaviors typical of autism and on evaluation of current functional skills. Approximately 75 percent of persons with autism are mentally retarded. Less than 5 percent of children with autistic traits have fragile X or some other, known chromosomal abnormality.

Although there is no cure, autism is treatable. Symptoms associated with autism often improve, as children start to acquire language and learn how to communicate their needs.

2. What are the known causes of autism?

The causes of autism are unknown in most cases. In a few cases, biologic causes have been identified, although none are unique to autism. Some prenatal factors include intrauterine rubella; tuberous sclerosis; chromosomal abnormalities, such as Down's syndrome; as well as brain abnormalities, such as hydrocephalus. Frequently cited postnatal conditions associated with autism are untreated phenylketonuria, infantile spasms, and herpes simplex encephalitis. In the majority of cases, however, no underlying cause can be identified.

The current theory favored by many experts is that autism is a genetically-based disorder that occurs before birth (Piven 1997). Studies of persons with autism are finding abnormalities in brain structures that develop in the first few weeks of gestation (that is, while the fetus is in the womb) (Rodier 1998). Evidence that genetics is an important, but not exclusive, cause of autism includes a three to 8 percent risk of recurrence in families with one affected child. A working group convened by the National Institutes of Health in 1995 reached a consensus that autism is a genetic condition. An issue unresolved by the group was the role of immune factors in autism spectrum disorders; it was suggested that studies to clarify the situation are needed.

3. Is there any scientific evidence that provides a link between autism and vaccines?

To date there is no convincing evidence that any vaccine can cause autism or any kind of behavioral disorder. A suspected link between measles, mumps, rubella (MMR) vaccine and autism has been suggested by some parents of children with autism. Typically,

symptoms of autism are first noted by parents as their child begins to have difficulty with delays in speaking after age one. MMR vaccine is first given to children at 12 to 15 months of age. Therefore autism cases with an apparent onset within a few weeks after MMR vaccination may simply be an expected but unrelated chance occurrence.

The only evidence that has been presented to suggest that MMR vaccine may be associated with autism has been published by the Lancet (Wakefield et al 1998). An editorial published in the same issue, however, discussed concerns about the validity of the study (Chen and DeStefano 1998). Based on data from 12 patients, Wakefield and colleagues speculated that MMR vaccine may have been the possible cause of bowel problems which led to a decreased absorption of essential vitamins and nutrients which resulted in developmental disorders like autism. No scientific analyses were reported, however, to substantiate the theory. Whether this series of 12 cases represent an unusual or unique clinical syndrome is difficult to judge without knowing the size of the patient population and time period over which the cases were identified. If there happened to be selective referral of patients with autism to the researchers' practice, the reported case series may simply reflect such referral bias. Moreover, the theory that autism may be caused by poor-absorption of nutrients due to bowel inflammation is not supported by the clinical data. In at least 4 of the 12 reported cases, behavioral problems appeared before the onset of symptoms of inflammatory bowel disease (that is, the effect preceded the cause). Furthermore, since publication of their original report in February of 1998, Wakefield and colleagues have published another study in which highly specific laboratory assays in patients with inflammatory bowel disease, the posited mechanism for autism after MMR vaccination, were negative for measles virus (Chadwick 1998, Duclos 1998).

Other recent investigations also do not support a causal association between MMR (or other measles-containing vaccines) and autism or inflammatory bowel disease. In one investigation, a Working Party on MMR Vaccine of the United Kingdom's Committee on Safety of Medicines (1999) was charged with the evaluation of several hundred reports, collected by a firm of lawyers, of autism, Crohn's disease, or similar disorders developing after receipt of MMR or MR vaccines. The Working Party conducted a systematic, standardized review of parental and physician information. Although acknowledging that it is impossible to prove or refute the suggested associations (because of variable data quality, biased selection of cases, and lack of a control group), the Working Party concluded that the information available "... did not support the suggested causal associations or give cause for concern about the safety of MMR or MR vaccines."

A study by Taylor and colleagues provides population-based evidence that overcomes many of the limitations faced by the Working Party and by Wakefield and colleagues (Taylor 1999; DeStefano and Chen 1999). The authors identified all 498 known cases of autism spectrum disorders (ASD) in certain districts of London born in 1979 or later and linked them to an independent regional vaccination registry. ASD includes classical autism, atypical autism, and Asperger's syndrome, but the results were similar when cases of classical autism were analyzed separately. The authors first showed that the known number of ASD cases has been increasing since 1979 and there was no jump after the introduction of MMR vaccine in 1988. Second, they found that cases vaccinated before 18 months of age had similar ages at diagnosis as did cases who had been vaccinated after 18 months or not vaccinated, indicating that vaccination does not result in earlier expression of autistic characteristics. Third, they showed that at age two years the MMR vaccination coverage among the ASD cases was nearly identical to coverage in children in the same birth cohorts in the

whole region, providing evidence of an overall lack of association with vaccination. Finally, Taylor and colleagues showed that the first diagnosis of autism or initial signs of behavioral regression were not more likely to occur within time periods following vaccination than during other time periods. A weak statistical association was found between MMR vaccination and initial parental concern, but this appears to have been due to parents' difficulty in recalling precise age at onset and a preference for approximating the age as 18 months.

A study of the population of children in two communities in Sweden also found no evidence of an association between MMR vaccination and autism (Gillberg and Heijbel 1998). That study found no difference in the prevalence of autism in children born after the introduction of MMR vaccination in Sweden compared with children born before.

4. Is there a theoretical possibility that there is a connection between autism and MMR vaccine or any other vaccine?

If measles vaccine, or any other vaccine, causes autism then it would have to be a very rare occurrence since millions have children have received vaccines without ill health effects.

In January 1990, an Institute of Medicine committee examining possible health effects associated with DPT vaccine concluded that there was no evidence to indicate a causal relation between DPT vaccine or the pertussis component of DPT vaccine and autism. Also, data obtained from CDC's Monitoring System for Adverse Events Following Immunization (MASAEFI) system, showed no reports of autism occurring within 28 days of DPT immunization from 1978-1990, a period in which approximately 80.1 million doses of DPT vaccine were administered in the United States.

From January 1990 through February 1998, only 15 cases of autism behavior disorder after immunization were reported to the Vaccine Adverse Events Reporting System (VAERS). Because of the small number of reports over an 8 year period, the cases reported are likely to represent unrelated chance occurrences that happened around the time of vaccination. The most frequent vaccines cited in the reports were diphtheria, tetanus, pertussis (DPT), oral polio vaccine (OPV), and MMR. Other vaccines reported as having a possible association with autism were *Haemophilus influenzae* type B and Hepatitis B.

Recently, the National Childhood Encephalopathy Study (NCES) was examined to see if there was any link between measles vaccine and neurological events. Researchers in England found no indication that measles vaccine contributes to the development of long term neurological damage, including educational and behavioral deficits (Miller et al 1997).

5. What are the known side effects associated with MMR vaccination?

Most persons have no reactions after receiving a MMR vaccination. About 5%-15% of vaccinees may develop a fever 5-12 days after MMR vaccination and 5% may develop a rash. Central nervous system conditions, including encephalitis and encephalopathy, have been reported with a frequency of less than one per million doses administered.

As with the administration of any agent that can produce fever, some children may have a febrile seizure. Most convulsions following measles vaccination are simple febrile seizures, and they affect children without known risk factors. An increased risk of febrile convulsions may occur

among children with a prior history of convulsions.

6. What is the federal government doing to protect the health of persons who receive MMR vaccine?

There are no proven data to suggest that measles vaccine will increase the risk of developing autism or any other behavioral disorder. The CDC continues to recommend two doses of MMR vaccine for all children who do not have a known medical contraindication; the first dose is recommended at 12-15 months of age and the second dose is recommended at either 4-6 years of age or at 11-12 years of age. For more information about contraindications to MMR vaccine see the Advisory Committee's Recommendations for Immunization Practices on MMR vaccine. (MMWR 1998).

To assure the safety of vaccines, The Centers for Disease Control and Prevention (CDC), the Food and Drug Administration (FDA), the National Institutes of Health (NIH), and other Federal agencies routinely monitor and conduct research to examine any new evidence that would suggest possible problems with the safety of vaccines. Currently, CDC is conducting a study in the metropolitan Atlanta area to further evaluate any possible association between MMR vaccination and autism. Results of this study are expected sometime in 2000.

Health Care providers that administer vaccines are required to report to the Vaccine Adverse Event Reporting System (VAERS) certain adverse health events that occur in persons who have received vaccines. Some of these reports are related to vaccines and other reports are not related but occur from other causes and happen around the time vaccines are given. Anyone can fill out a report, you do not have to be a health care provider. The Centers for Disease Control and Prevention(CDC) and the Food and Drug Administration (FDA) collect and analyze these reports. If you wish to report a health problem that followed vaccination you can do so by calling the Vaccine Adverse Event Reporting System (VAERS) at 1-800-822-7967.

The National Immunization Program has established a National Immunization Information Hotline to help answer questions people may have about vaccines. The phone number for the National Immunization Information Hotline is 1-800-232-2522 (English) and 1-800-232-0233 (Spanish).

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Fact sheet last updated 8/99

Vaccines and Chronic Disease

Q. Do vaccines cause chronic diseases, such as autism, diabetes, Crohn's disease, and cancer?

A. After decades of vaccine use in the United States, current research shows no reliable evidence proving that vaccines cause chronic illness. Vaccine safety research--including, whenever possible, research into theories linking vaccines to chronic diseases--is being conducted on a regular basis in the United States and overseas to make sure the public is receiving the safest possible vaccines.

- In some instances, researchers have published articles about their studies that support their theories about vaccine and chronic illness; however, when other researchers attempt to duplicate their results (the test of good research), they often can't. Medical conclusions about the safety of vaccines or the cause of a disease must be judged on the quality of the scientific research and the weight of scientific evidence.

- Because no vaccine is without risk, when medical and public health professionals recommend vaccines for infants and children to protect children against serious infectious diseases, they must balance the scientific evidence of benefits, costs, and risks.

- The balance of benefits and risks can change as diseases are controlled or eradicated. For example, smallpox has been eradicated worldwide. The risk of complications associated with smallpox vaccine now outweigh any theoretical risk of contracting smallpox or a related virus, for the general population. Therefore, smallpox vaccine is no longer recommended for use in the general population.

- CDC believes that parents should be fully informed about the risks and benefits of vaccination and should talk to their child's trusted health care provider.

Please call CDC's National Immunization Information Hotline: **1-800-232-2522, for English**

1-800-232-0233, for Spanish *or visit CDC's Internet address* **http://www.cdc.gov/nip**

CDC **Informing Parents**

Q. What is done to be sure parents are fully informed about the benefits and risks of vaccinating their children?

A. By law, parents, guardians, or patients are informed before vaccinations are administered. Parents, guardians or patients must be given information in writing about the risks and benefits of vaccination before a vaccine is administered. CDC believes parents should discuss their children's immunizations with a trusted health care provider.

- Under the National Childhood Vaccine Injury Act, section 2126 of the Public Health Service Act, all health care providers in the United States who administer any vaccine containing diphtheria, tetanus, pertussis, measles, mumps, rubella, or polio vaccine shall, prior to administration of *each dose* of the vaccine, provide a copy of the relevant vaccine information materials that have been produced by the Centers for Disease Control and Prevention.

- Vaccination is an accepted, globally prescribed health practice. Today, many managed care organizations, public health clinics and health insurance companies struggle to define what are basic rights and acceptable levels of care for their clients. In most cases, children's immunizations are included as a requirement for acceptable quality of care. To withhold immunization is perceived as an unacceptable level of care by these groups.

- American courts have addressed the legal issue of whether or not the government could compel vaccination. In the leading case, *Jacobson v. Massachusetts*, 197 U.S. 11 (1905), Jacobson appealed to the Supreme Court, challenging the constitutionality of the statute on the ground that a requirement that he submit to vaccination was an unreasonable infringement of his personal liberty. The Court unanimously rejected this argument and was not prepared to allow a minority in a community to enjoy the general protection afforded by an organized immunization program in that community or subordinate the safety of an entire community to the notions of a single individual who chooses to remain a part of that population. American courts have been supportive of laws and programs designed to increase the level of vaccination in the United States.

- CDC materials, developed in consultation with concerned parents, describe the disease, and explain the benefits and risks of the vaccine, and recommend when children should be given the vaccine.

Please call CDC's National Immunization Information Hotline: **1-800-232-2522, for English 1-800-232-0233, for Spanish** *or visit CDC's Internet address* **http://www.cdc.gov/nip**

Additives in Vaccines

Why are chemicals and other substances added to vaccines?

Many things in today's world, including foods and medicines, have chemicals added to them to prevent the growth of germs and reduce spoilage. Chemicals are added to vaccines for similar reasons, to inactivate a virus or bacteria and to stabilize it, helping to preserve the vaccine and prevent it from losing its potency over time.

Some additives are used in the production of vaccines. Vaccines may include suspending fluid (e.g., sterile water, saline, or fluids containing protein); preservatives and stabilizers (e.g., albumin, phenols, and glycine); and adjuvants or enhancers that help the vaccine improve is immunogenicity.

What substances are found in vaccines?*

- *Antibiotics* are added to vaccines to prevent the growth of germs (bacteria) in vaccine cultures. Neomycin is one of the more common antibiotics used for this purpose. Penicillin is not used in vaccines today because some persons are sensitive to penicillin.

- *Aluminum* gels or salts of aluminum are added as adjuvants to help the vaccine stimulate production of antibodies to fight off diseases. Adjuvants are substances that aid other substances in their action. In vaccines, adjuvants may be added to help promote an earlier response, more potent response, or more persistent immune response to disease.

- *Formaldehyde* is used to inactivate bacterial products for toxoid vaccines. It is also used to kill unwanted viruses and bacteria that might be found in cultures used to produce vaccines.

- *Monosodium glutamate* (MSG) is used as a stabilizer in a few vaccines. Stabilizers help the vaccine remain unchanged even in the presence of forces that would normally change the vaccine's state or condition (such as heat, light, acidity, humidity etc.). Monosodium Glutamate is also found in many foods, especially Asian foods and flavor enhancers.

- *Egg protein* is found in vaccines prepared using embryonated chicken eggs. Ordinarily, persons who are able to eat eggs or egg products safely can receive these vaccines. Persons with histories of anaphylactic allergy to eggs or egg proteins should not.

- *Sulfites* such as sodium metabisulfite are also stabilizers. Sulfites might be added to some vaccines to help stabilize and preserve the vaccine if it were exposed to adverse

conditions. Sulfites are also found in many foods and some alcoholic beverages.

- *Thimerosal* is a preservative that might be added to help keep the vaccine from spoiling. Thimerosal contains mercury and is made from a combination of ethyl mercuric chloride, thiosalicylic acid, sodium hydroxide and ethanol. Most patients do not develop reactions to thimerosal given as a component of vaccines even when patch or intradermal tests for thimerosal indicate hypersensitivity. Hypersensitivity to thimerosal usually consists of local, delayed reactions. Thimerosal is also found in some contact lens solutions and throat sprays.

How can I find out what chemical additives are in specific vaccines?

Ask your health care provider or pharmacist for a copy of the vaccine package insert. The package insert lists ingredients in the vaccine and discusses any known adverse reactions.

Should I stop taking vaccinations if I am allergic to any of these chemicals?

The amount of chemical additives found in vaccines is very small and may not be enough to cause a serious allergic response. However, if you have concerns about receiving a vaccination, you should always discuss it with your health care provider. You should also consult your health care provider if you have had any reaction to a vaccine in the past.

References:

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Not all vaccines include all of these additives. Allergic reactions to vaccines are rare. If you have previously experienced an allergic reaction to a dose of vaccine or believe you are sensitive to any components of a vaccine, consult your health care provider before vaccination.

To learn more about children's immunizations, vaccinations, or baby shots from a CDC information specialist, please call CDC's National Immunization Information Hotline:

1-800-232-2522, for English

1-800-232-0233, for Spanish

or visit CDC's Internet address **http://www/cdc.gov/nip**

April 15, 1994 / 43(RR-5);1-18

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

Ingenuity, knowledge, and organization alter but cannot cancel humanity's vulnerability to invasion by parasitic forms of life. Infectious disease which antedated the emergence of humankind will last as long as humanity itself, and will surely remain, as it has been hitherto, one of the fundamental parameters and determinants of human history.

- William H. McNeill in Plagues and Peoples, 1976

Summary

The spectrum of infectious disease is changing rapidly in conjunction with dramatic societal and environmental changes. World- wide, explosive population growth with expanding poverty and urban migration is occurring; international travel and commerce are increasing; and technology is rapidly changing -- all of which affect the risk of exposure to infectious agents.

Recent examples of important emerging infectious diseases include prolonged diarrheal illness due to waterborne Cryptosporidium, hemorrhagic colitis and renal failure from foodborne Escherichia coli O157:H7, pneumonia and middle-ear infections caused by drug-resistant pneumococci, and rodentborne hantavirus pulmonary syndrome. These diseases as well as resurgent diseases (e.g., tuberculosis and cholera) illustrate human vulnerability to microorganisms in the environment. Three recent reports by the Institute of Medicine document the need to address emerging infectious disease threats.

In partnership with representatives from health departments, other federal agencies, medical and public health professional associ- ations, and international organizations, CDC has developed a strategic plan to address emerging infectious disease threats. The plan contains four goals that emphasize surveillance, applied research, prevention and control, and public health infrastructure. To ensure sustain- ability, plan implementation will be approached in stages, as a long- term endeavor with emphasis on extramural programs. As health-care reform proceeds, priority should be given to strengthening partner- ships between health-care providers, microbiologists, and public health professionals to detect and control emerging infectious diseases.

INTRODUCTION

Once expected to be eliminated as a public health problem, infectious diseases remain the leading cause of death and disability- adjusted life years (DALYs) worldwide (1) and are among the leading causes of death in the United States (2). Dramatic changes in society, technology, and the environment, together with the diminished effectiveness of certain approaches to disease control, usher in an era wherein the spectrum of infectious diseases is expanding, and many infectious diseases once thought to be controlled are increasing (Box 1 Table B1).

The term "emerging infectious diseases" refers to diseases of infectious origin whose incidence in humans has either increased within the past two decades or threatens to increase in the near future (3). To effectively address emerging infectious diseases, CDC has developed a strategic plan emphasizing

surveillance, research, and prevention activities necessary to maintain a strong defense against infectious diseases that affect, or threaten to affect, the public's health.

The goals of this plan address priorities for surveillance, applied research, prevention and control, and public health infra- structure, respectively:

Goal I. Detect, promptly investigate, and monitor emerging patho-

gens, the diseases they cause, and the factors influencing their emergence. Goal II. Integrate laboratory science and epidemiology to optimize

public health practice. Goal III. Enhance communication of public health information about

emerging diseases and ensure prompt implementation of prevention strategies. Goal IV. Strengthen local, state, and federal public health infra-

structures to support surveillance and implement prevention and control programs.

BACKGROUND

The Concept of Emergence

Many factors or combinations of factors can contribute to disease emergence. Newly emergent infectious diseases may result from changes in or evolution of existing organisms; known diseases may spread to new geographic areas or human populations; or previously unrecognized infections may appear in persons living or working in areas undergoing ecologic changes (e.g., deforestation or reforestation) that increase human exposure to insects, animals, or environmental sources that may harbor new or unusual infectious agents (Table_1) (4-7).

Infectious diseases may reemerge because of either the develop- ment of antimicrobial resistance in existing agents (e.g., gonorrhea, malaria, pneumococci) or breakdowns in public health measures for previously controlled infections (e.g., cholera, tuberculosis, and pertussis) (3).

The Burden of Infectious Diseases

In the United States and elsewhere, infectious diseases increas- ingly threaten public health and contribute substantially to the esca- lating costs of health care. For example, childhood ear infections are the leading cause of patient visits to pediatricians, and the incidence of visits for these infections increased 150% during 1975- 1990 (8). In addition, infectious agents may be causing diseases previously considered noninfectious: Helicobacter pylori has a well- established association with peptic ulcer disease and gastritis (9); sexually transmitted human papillomavirus is associated with cervical cancer (10); and infection with hepatitis C virus -- now recognized as a leading cause of chronic liver disease and cirrhosis in the United States -- occurs in an estimated 150,000 persons annually (11). Chlamydia infections have long been implicated in infertility and, more recently, have been tentatively associated with coronary artery disease (12), and rodentborne hantaviruses may play a role in hyper- tensive renal disease (13).

Infectious diseases account for 25% of all visits to physicians each year, and antimicrobial agents are the second most frequently prescribed class of drugs in the United States. (14,15). Direct and indirect costs of infectious diseases (e.g., economic losses and days of disability) may exceed an estimated $120 billion. Such approxi- mations, however, most likely underestimate the burden of infectious diseases. For example, the International Classification of Diseases (ICD-9) distributes infectious diseases across several categories, obscuring their public health impact (e.g., the classification of endocarditis among cardiovascular diseases and the classification of meningitis and middle-ear infections among diseases of the nervous system and sense organs, respectively).

The Threat of Emerging Infections

As a consequence of changes in society, technology, and the environment, pathogens evolve or spread, and the spectrum of infectious diseases expands. Emerging infections, such as human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), illustrate that no nation can be complacent regarding human vulnerability to microorganisms in the environment. Since the early 1970s, the U.S. public health system has been challenged by other newly identified pathogens and syndromes, such as Legionnaires' disease, Lyme disease, toxic shock syndrome, hepatitis C virus, and, most recently, hantavirus pulmonary syndrome (16-23). Moreover, the incidence of many diseases widely presumed to be under control -- such as cholera (24), dengue (25), yellow fever (26), and tuberculosis (TB) (27,28) -- has increased in many areas or spread to new regions or populations throughout the world. Because of widespread use and misuse of antimicrobial drugs, their effectiveness in treating common bacterial infections is diminishing, resulting in prolonged illnesses, higher mortality rates, and higher health-care costs (Figure_1) (29-35).

Emerging infections are particularly serious in persons with lowered immunity, such as those infected with HIV and those receiving immunosuppressive therapy for cancer or organ transplantation -- populations whose numbers are increasing (Figure_2). Other groups that may be disproportionately affected by emerging infections include the elderly; persons being cared for in institutional settings, such as hospitals and nursing homes; and persons with inadequate access to health care, such as the homeless, migrant farm workers, and others of low socioeconomic status.

The number of children attending day care facilities has increased in the past decade as more mothers of young children have entered the work force. These children, now numbering more than 11 million, are at a substantially increased risk for enteric infections, such as hepatitis A, giardiasis, and cryptosporidiosis; acute respir- atory illnesses; and middle-ear infections. Also, children who become infected can infect other members of a household (36).

Emerging infections transmitted by contaminated public water supplies place entire communities at risk. In the spring of 1993, contamination of a municipal water supply with the intestinal parasite Cryptosporidium caused the largest recognized outbreak of waterborne illness in the history of the United States; an estimated 403,000 persons in Milwaukee, Wisconsin, had prolonged diarrhea, and approxi- mately 4,400 persons required hospitalization (personal communication, Jeffrey P. Davis, communicable disease epidemiologist, Wisconsin). Large segments of populations may also be exposed to emerging infections through contaminated food products. For example, in 1993, hamburgers contaminated with the bacterial pathogen Escherichia coli O157:H7 and served at a fast-food restaurant chain caused a multistate outbreak of hemorrhagic colitis (bloody diarrhea) and serious kidney disease, resulting in the deaths of at least four children (37,38).

Limitations in both surveillance and the availability of appro- priate diagnostic tests constrain public health efforts to prevent and control outbreaks. Both E. coli O157:H7 and Cryptosporidium were first recognized as important human pathogens in the early 1980s, but neither has received adequate public health attention (Figure_3).

Exposure to certain animals also poses a risk for emerging infectious diseases. Hantavirus pulmonary syndrome, first recognized in the southwestern United States in 1993, has been linked to exposure to infected rodents in more than a dozen states. More than 60 cases have been detected; of those, more than half have died (Figure_4) (20-23).

Once considered "exotic," tropical infectious diseases are having an increasing effect on the U.S. public. Recent examples include severe illness and at least one death due to cholera among interna- tional airline passengers arriving in California (39); malaria among residents of southern California and immigrants in North Carolina (40,41); fever and heart failure in New York and Canada among patients who received blood transfusions contaminated with the bloodborne parasite (Trypanosoma cruzi) that causes Chagas' disease in Latin America (42,43); and a newly described form of leishmaniasis among troops returning from the Persian Gulf conflict (44,45).

From a historical perspective, cholera, smallpox, and plague are examples of infectious diseases that spread globally with devastating impact, often during periods of rapid economic change or population growth (7). Today, travel and commerce have fostered the worldwide spread of pathogens such as

INFECTIOUS DISEASES

AUTHORIZING LEGISLATION - Section 301, 307, 310, 311, 317, 318, 322, 325, 327, 352, 361-369 and 1102 of the Public Health Service Act and Sections 212, 234, and 412(b)(5) of the Immigration and Nationality Act.

	FY 1998 Comparable	FY 1999 PB Comparable	FY 1999 House Allowance	FY 2000 Request
BA	112,856,000	137,515,000	137,636,000	216,746,000
FTE	904	950	950	1,018

2000 Authorization. . . . . .Indefinite

PURPOSE AND METHODS OF OPERATION

Once expected to be eliminated as a public health problem, infectious diseases remain the leading cause of death worldwide. In the United States and elsewhere, infectious diseases increasingly threaten public health and contribute significantly to the escalating costs of health care. They are a continuing menace to all segments of society, regardless of age, gender, lifestyle, ethnic background and socioeconomic status. Earlier predictions of the elimination of infectious disease did not take into account changes in demographics and human behaviors and the extraordinary ability of microbes to adapt, evolve, and develop resistance to drugs. As early as the 1950's, penicillin began to lose its power to cure infections caused by Staphylococcus aureas, a common bacterium that can cause serious illness. In 1957 and 1968, new strains of influenza emerged in China and spread rapidly around the globe, and in the 1970's there was a resurgence of sexually transmitted diseases. Also during the 1970s, several new diseases were identified in the United States including Legionnaires' disease, Lyme disease, toxic shock syndrome, and Ebola hemorrhagic fever. Hepatitis C virus (HCV) infection, now shown to be the most common bloodborne infection in the United States, was one of thirty new diseases discovered between 1973 and 1995. The re-emergence of diseases such as TB, malaria, rabies, dengue, and growing drug resistance of many pathogens continued to dramatically change the global and domestic landscape of infectious diseases. By the early 1990s, it had been demonstrated that the threat of infectious diseases was increasing in the United States and elsewhere.

> Between 1973 and 1995, more than thirty newly emerging infectious diseases were identified.

The Institute of Medicine's Committee on Emerging Microbial Threats to Health in the United States defined influenza virus as the "prototype emerging infection." Recently, the recognition of an avian strain of influenza in Hong Kong raised the possibility that an influenza pandemic can occur. Such a pandemic will have a high death rate, carry with it a huge economic burden, and create massive disruption of public life.

> While we cannot predict when or where disease outbreaks will strike, we can recognize that they will occur and our response must be rapid and decisive.

Domestic and international public health infrastructures must be strengthened and comprehensive, integrated, and operational systems must be in place to support rapid identification, response, control, and prevention of these threats.

CDC's efforts in infectious disease prevention focus on preventing illness, disability, and death caused by infectious diseases through the following mechanisms:

- Conducting national surveillance for infectious diseases. Surveillance data provide the basis for public health action. It is used to evaluate disease control interventions, identify disease risk factors, and improve clinical practice, as well as to detect outbreaks.

- Conducting research to develop new or improved diagnostic tests. Diagnostic tests are essential to disease surveillance and outbreak response, as well as to clinical management of patients with infectious diseases.

- Working with State and local health departments and private health care providers to transfer and accelerate the general application of effective infectious disease prevention strategies. Human behavior is often a key determinant in the emergence of new disease, and changing human behavior is often the most cost-effective (and sometimes the only practical) prevention strategy.

- Strengthening the nation's capability to respond to outbreaks of new and re-emerging infectious diseases. A strong and flexible public health infrastructure is the best defense against any disease outbreak.

- Developing and implementing strategies to prevent the occurrence and spread of antimicrobial resistance. Emergence of drug resistance in bacteria, fungi, parasites, and viruses threatens to create an era where drugs are no longer useful for many common infectious diseases. Social and behavioral risk factors associated with the emergence and spread of antimicrobial resistance need to be examined and behavioral interventions developed, implemented, and evaluated.

- Strengthening the capacity of the public health system at the State and local levels to provide leadership to their communities in addressing current and emerging critical health problems. Working with state and local health departments, CDC has begun a process to identify the essential core requirements that a health department must have to protect its population against infectious disease threats.

- Developing a nationwide network for communicating information to the public health community. The prompt detection of domestic outbreaks depend on the flow of reliable surveillance data from physicians, hospitals, clinical laboratories, and epidemiologists to state and local health departments and CDC.

- Delivering training and information to the public health workforce using a variety of methods (self-study, computer-based training, satellite teleconferences, audio conference, etc.) through the Public Health Training Network, as well as through other efforts. Training and education ensures that today's and future generations will be well-prepared to respond to infectious disease threats.

Funding for infectious diseases the last five years:

FY	Funding	FTE
1995	54,340,000	940
1996	62,153,000	825
1997	87,720,000	863
1998 Comparable	112,856,000	904
1999 PB Comparable	137,515,000	950

RATIONALE FOR BUDGET REQUEST

The FY 2000 budget request of $216,746,000 represents an increase of $79,231,000 and 68 FTEs above the FY 1999 Comparable President's Budget. This increase will support the Secretary's initiative to increase food safety by enhancing surveillance and outbreak investigations at state and federal levels by linking state

health department and federal agencies together to coordinate the response to foodborne diseases. It will also support the Secretary's initiative to prevent emerging infectious diseases and will build national and state capacity needed to respond quickly to the threat of emerging infectious diseases.

PREVENTING EMERGING INFECTIOUS DISEASES ($60 million and 49 FTES)

In 1994, CDC began working with other Federal agencies, state and local health departments, and other partners to strengthen our nation's capacity to recognize and respond to infectious disease threats through implementation of the CDC plan, *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States.* These efforts were reaffirmed in 1996, when the Presidential Decision Directive (PDD) on emerging infectious diseases (NSTC-7) established a new national policy to address the growing health and national security threat represented by infectious diseases. Subsequently, the second phase of CDC's effort, *Preventing Emerging Infectious Diseases: A Strategy for the 21st Century,* has evolved, taking into account new challenges and building on the experience, success, and knowledge gained from the initial plan. CDC intends to publish this updated plan in 1998.

The FY 2000 budget initiative focuses on building a strong and flexible public health infrastructure, recognizing that skilled epidemiologists, strong public health laboratories, and coordinated communications and disease reporting systems are essential for developing sustainable disease prevention strategies, and are the best defense against any disease outbreak. The initiative stresses the need for developing emergency preparedness at all levels of government for an organized, rapid, and effective response in the event of pandemics (worldwide epidemics), such as influenza, and large scale disease outbreaks. New strains of influenza can emerge unpredictably and spread rapidly and pervasively through susceptible populations. Experts agree that future pandemics of influenza are likely, if not inevitable. In the U.S. alone, preliminary estimates indicate than an influenza pandemic would cause between 100,000 - 227,000 deaths, and the economic impact would range from $80 - $187 billion.

The Institute of Medicine's Committee on Emerging Microbial Threats to Health in the United States defined influenza virus as the "prototype emerging infection". During a typical influenza season in the United States, about 10 to 20 percent of the population becomes ill and approximately 20,000 persons die. A pandemic (worldwide epidemic) of influenza occurs when a novel influenza virus emerges. Infection would occur in all age groups spreading rapidly to new geographic areas because the entire population would be susceptible to the new strain. During a pandemic as many as 50 percent of the population may be affected and mortality rates may be three times higher than those seen during interpandemic years. In addition, hundreds of thousands of hospitalizations due to pneumonia and other complications and massive disruptions of public life could occur. The last two pandemics, with more than 70,000 deaths occurring in 1957 and 28,000 in 1968, totaled an estimated $32 billion in direct and indirect costs. Preliminary estimates indicate that an influenza pandemic would cost the United States between 100,000 and 227,000 deaths with an economic cost ranging from $80 to $187 billion.

Experts agree that future pandemics of influenza are certain and that we may indeed be "due" to suffer such an event. The recent recognition of H5N1 influenza in Hong Kong highlights this potential and current investigations continue to document the emergence in China of pandemic strains of influenza viruses. Global virologic surveillance is the cornerstone of influenza control. Bolstering surveillance activities in China and other Pacific Basin countries, as well as in under-served geographic areas such as the former Soviet Union and Latin America, are critically needed. The primary purpose of global and national networks is to detect the emergence and spread of new influenza variants which signal a need to update the formulation of a new vaccine. Establishment of laboratories, improvements in methods and training, facilitated communication, and sharing of expertise and reagents are needed. As new variants can emerge in any country and at any time, development of global and national epidemiologic and laboratory-based surveillance systems must proceed in a timely manner. This must include the establishment of world-wide database for both animal and human strains of influenza viruses needed for the rapid detection of new variants.

In order to strengthen our readiness, $ 20 million is requested to allow CDC to implement enhanced disease-

and laboratory-based surveillance systems domestically and in international sites; improve laboratory capacity at the federal/state/local levels to culture and subtype respiratory specimens for influenza viruses; and develop operational plans for rapid vaccine delivery, and rapid vaccine delivery, and rapid communications through national and international collaborations.

The following specific CDC activities are essential for influenza pandemic surveillance:

Domestic Surveillance

- Strengthen capacity of state and local public health laboratories to rapidly isolate and subtype influenza viruses
- Enhance ability of CDC and state health agencies to increase and sustain sentinel physician-based disease surveillance for influenza
- Improve ability to disseminate, exchange, and integrate surveillance information among CDC and state and local health departments and the military
- Strengthen ability to provide influenza surveillance training and consultation
- Enhance ability to rapidly implement national surveillance during a pandemic in special populations, such as children, hospitals, and groups at high-risk for complications
- Develop plans to implement vaccine effectiveness, vaccine adverse effects, and other special investigations needed during a pandemic
- Develop capacity to monitor animal influenza viruses that have the potential to cause disease in humans

International Surveillance

- Strengthen international laboratory capabilities, especially in China and the Pacific Basin countries, to rapidly isolate and subtype influenza viruses and to monitor antiviral resistance
- Strengthen international capabilities to rapidly detect, investigate, and monitor related disease activity
- Develop a bank containing serologic and molecular reagents to facilitate rapid characterization of new influenza viruses
- Provide support for an international database containing influenza virus gene sequences to aid efforts in vaccine development and studies on virus transmissibility and virulence

The prevention and control of hepatitis C virus (HCV) infection is another major focus of this initiative. Chronic liver disease is the tenth leading cause of death among adults in the United States and it is estimated that 40-60% of chronic liver disease is caused by HCV. HCV-related acute and chronic liver disease causes 8,000-12,000 deaths annually and the medical and work loss costs are estimated to exceed $600 million annually. Approximately 4 million Americans are infected with HCV. Most of these chronically infected persons are not aware of their infection and are not clinically ill, because symptoms of hepatitis C-related chronic liver disease may not develop for 10 to 20 years after infection. As part of the *National Prevention and Control Plan for Hepatitis C Virus*, strategies to identify, test, and refer persons at risk for HCV will be initiated.

This initiative supports the President's Initiative on Race. The activities described below address PDD/NSTC-7.

This initiative will accomplish the following:

- Continue to implement programs to build core epidemiology and laboratory capacity domestically by providing financial and technical assistance to 10 additional state and large local health departments (total of 43) for enhanced surveillance and response;

- Strengthen the current network of nine (9) regional population-based Emerging Infections Programs (EIP) and expand it to include one new site (a total of 10) to enhance geographic and demographic representation;

- Develop and begin implementation of a national HCV information and education campaign targeted to at-risk populations and health care professionals; make resources available for financial and technical assistance for up to 50 state health departments to begin development of statewide HCV programs; and implement HCV prevention and demonstration projects in select high prevalence states or major cities;

- Implement CDC activities in the national *Influenza Pandemic Preparedness Plan for the United States*, including enhanced disease- and laboratory-based surveillance systems domestically and in international sites; improve laboratory capacity at the federal/state/local level to culture and subtype respiratory specimens for influenza virus; and develop operational plans for rapid vaccine delivery, and rapid communications through national and international collaborators;

- Investigate, monitor, and establish surveillance for antimicrobial use, resistance, and related risk factors;

- Build global capacity by collaborating with WHO and other international agencies to develop reference laboratories and provide epidemiologic and laboratory training in the Americas, Africa, and Asia; and

- Design and deliver distance-based educational and training programs for emerging infections and drug resistance for practicing health professionals and those in training.

NATIONAL FOOD SAFETY INITIATIVE ($18,000,000 AND 19 FTES)
Secretary's Priority

Although the United States has one of the safest food supplies in the world, the public health burden of foodborne diseases is still substantial. The Council for Agricultural Science and Technology has estimated that as many as 9,000 deaths and 6.5 to 33 million illnesses in the United States each year are food related. Foodborne disease costs the U. S. economy several billion dollars annually. There is an urgent need for better, more representative data on which to base and evaluate programs to improve food safety. Additional resources are required in FY 2000 to build as quickly as possible health department capacity and the CDC programs that support foodborne disease surveillance and outbreak response capacity in State and local health departments.

The increase in National Food Safety Initiative resources requested in FY 2000 will increase CDC's capacity to identify new foodborne hazards and characterize the risk posed by those hazards, increase the speed with which the presence of hazards in foods can be determined and controlled, and increase the accuracy and timeliness of public health data that justify food safety control programs and evaluate their effectiveness. The specific plan for development and expansion of the Food Safety program includes the following components: 1) increasing the number of states that are trained, equipped and competent to perform pulse field gel electrophoresis (PFGE) and microscopic identification of foodborne parasites; 2) increase the number of foodborne pathogens that CDC can subtype; 3) increase the number of states that can implement the newest subtyping methods; and 4) increase the number of organisms for which CDC has established a PFGE subtype library.

In 1997, in response to the growing concern about food safety, the President announced the National Food Safety Initiative. The activities described below represent the ongoing expansion of the Presidential Initiative, focusing on building a national early warning system for hazards in the food supply by enhancing the capacity at the State and federal levels for surveillance and outbreak investigations. As an example, PulseNet, a national network of public health laboratories that perform DNA "fingerprinting" on bacteria that

may be foodborne, will be expanded to subtype an increasing number of pathogens on a routine basis and in response to food safety emergencies. PulseNet plays a vital role in surveillance and investigation of foodborne illness outbreaks that were previously difficult to identify by permitting rapid comparison of "fingerprint" patterns through an electronic database at CDC.

This initiative will accomplish the following:

- Expand the scope of the CDC/FDA/USDA Active Foodborne Disease Surveillance Program (FoodNet) at Emerging Infections Program (EIP) sites, in order to define the true incidence of many diagnosed foodborne infections and to assess the sources of these infections and potential for control. Evaluate trends in infection rates to determine important food safety factors influencing upward and downward trends;

- Build national capacity to identify and control foodborne disease outbreaks by training epidemiologists and laboratorians in investigating and analyzing public health foodborne diseases and pathogens;

- Develop and standardize new and rapid diagnostic techniques and molecular sub-typing ("fingerprinting") of foodborne pathogens for a minimum of one foodborne pathogen;

- Develop rapid gene-based diagnostic and sub-typing tools for a minimum of one new foodborne pathogen for better detection in clinical specimens and in foods, as well as implementation of standardized rapid sub-typing methods in four State public health laboratories;

- Conduct a detailed analysis of the economic impact of a foodborne outbreak; and

- Design and deliver distance-based educational and training programs for foodborne illnesses for school personnel, practicing health professionals and those in training at the State and local levels.

CURRENT SERVICE REQUIREMENTS/MANDATORY COSTS (+$1,231,000)

The FY 2000 request includes $1,231,000 to fully fund centralized mandatory costs associated with pay costs, within-grades, GSA rent, fuel, utilities, and other related items.

OUTPUTS

	FY 1998 Comparable	FY 1999 PB Comparable	FY 1999 House Allowance	FY 2000 Request
Emerging Diseases				
Provide support to state/local health departments for epidemiologic and laboratory capacity	30	33	33	43
Establish emerging infections programs	8	9	9	10
Implement and support domestic and global sentinel surveillance networks	3	4	4	7

INFECTIOUS DISEASES FUNCTIONAL TABLE:

	FY 1998 Comparable	FY 1999 PB Comparable	FY 1999 House Allowance	FY 2000 Request
Emerging Infections	$ 58,226,577	$ 78,985,000	79,106,000	$139,692,054
Hantavirus	7,391,411	7,022,029	7,022,029	7,084,889
Lyme Disease	7,770,236	7,381,916	7,381,916	7,447,997
Foodborne Diseases	14,290,061	19,476,000	19,476,000	37,650,344
Waterborne Diseases	296,656	280,884	281,000	283,398
Other Infectious Diseases	24,881,059	24,369,171	24,369,055	24,587,318
Total	112,856,000	137,515,000	137,636,000	216,746,000
FTE	904	950	950	1,018

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DOCUMENT NO. AND TYPE	SUBJECT/TITLE	DATE	RESTRICTION
001. list	re: phone numbers (2 pages)	n.d.	P6/b(6)

COLLECTION:
Clinton Presidential Records
Domestic Policy Council
Devorah Adler
OA/Box Number: 20468

FOLDER TITLE:
Super Bug

2012-0463-S
rc827

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P1 National Security Classified Information [(a)(1) of the PRA]
P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P3 Release would violate a Federal statute [(a)(3) of the PRA]
P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P5 Release would disclose confidential advice between the President and his advisors, or between such advisors [a)(5) of the PRA]
P6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

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b(1) National security classified information [(b)(1) of the FOIA]
b(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
b(3) Release would violate a Federal statute [(b)(3) of the FOIA]
b(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
b(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
b(9) Release would disclose geological or geophysical information concerning wells [(b)(9) of the FOIA]

Emerging Infectious Disease Threats

Download Brochure

CDC'S Plan for Addressing

Emerging Infectious Diseases

To address the threat of emerging infections, CDC, along with other federal agencies, state and local health departments, academic institutions, international organizations, and medical and public health experts, has developed a strategic plan Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States. In the plan, CDC proposes improvements in the public health system that would allow effective detection and prevention of emerging infections and ultimately reduce health care costs.

The CDC plan emphasizes four goals:

- rapid national and international detection and response to new, reemerging, and drug-resistant diseases
- applied research in disease diagnosis and prevention
- better communication and implementation of prevention strategies
- stronger connections between local, state, and federal public health providers to support disease tracking and prevention and control programs

CDC's plan reflects its commitment to meeting the challenge of emerging infectious diseases. The need is urgent. Methicillin-resistant *Staphylococcus aureus*, a common cause of infections in hospitals, could also develop resistance to vancomycin, the antibiotic used as a last resort to treat serious infections caused by this resistant bacteria. *Streptococcus pneumoniae*, a major cause of bacterial pneumonia, is becoming increasingly resistant to penicillin and many other antibiotics. Changing food industry practices, dietary choices of the American people, and food supplies gathered from every part of the globe bring new challenges to providing a diet safe from microorganisms.

CDC's strategy is based on the belief that it is much less costly, in both human suffering and economic terms, to prevent infectious diseases than to react with expensive treatment or containment measures to public health crises. Through the efforts proposed by CDC, the public health system in the United States will be better prepared to address the emerging infectious disease threats we confront.

New Infectious Diseases

Since the early 1970s, the U.S. public health system has been challenged by AIDS and a number of other apparently new infectious diseases, such as toxic shock syndrome, Legionnaires' disease, Lyme disease, *Escherichia coli* O157:H7 infection, cryptosporidiosis, hepatitis C, and hantavirus pulmonary syndrome.

Reemerging Infectious Diseases

A number of familiar diseases, such as cholera, malaria, tuberculosis (TB), dengue, and yellow fever, that were once under control in many parts of the world are increasing and spreading to new regions.

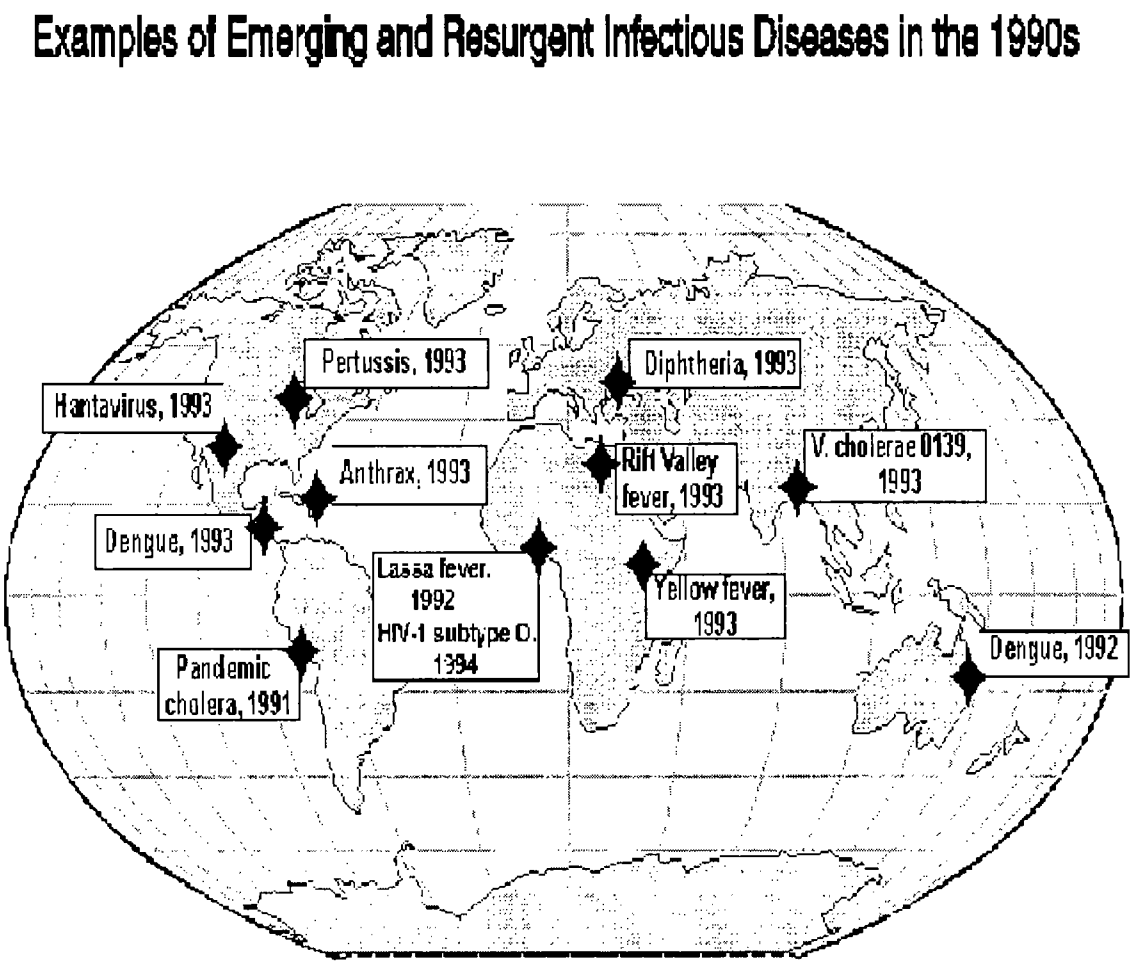
The National Foundation for Infectious Diseases estimates that the cost of drug resistance approaches $4 billion per year and is increasing.

Drug-Resistant Infectious Diseases

Emerging Infectious Disease Threats

In the United States and abroad, infectious diseases increasingly threaten our health and raise health care costs. As society and the environment change, infectious diseases also change. Microorganisms adapt to the changing enviromnment and are carried to every corner of the globe by travelers, whose numbers are growing. Advancing technology and changes in the way we live, eat, and interact with others have made us more vulnerable to infectious diseases. New infections are emerging, diseases thought to be under control are returning, and many dangerous microorganisms survive drugs that used to kill them.

Examples of New and Reemerging InfectiousDiseases in the 1990's



Who is at Risk?

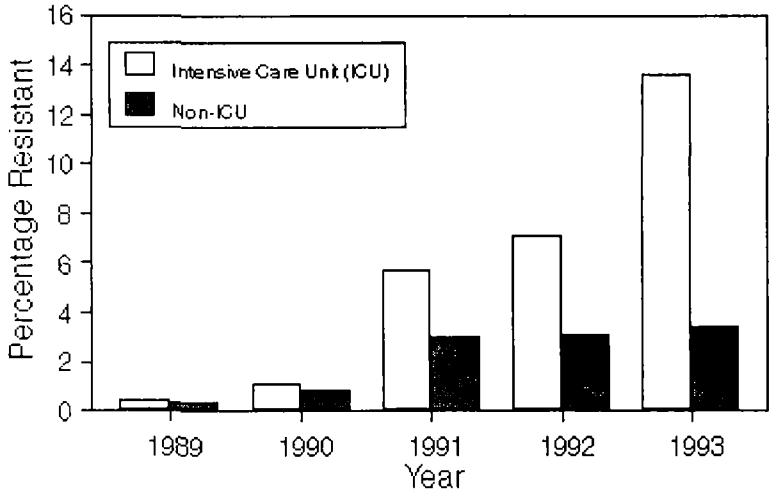
People with lowered immunity

Emerging infections are particularly serious in the growing number of people with lowered immunity, for example, those infected with HIV or receiving medications for cancer or organ transplantation. Others at higher risk are people with various underlying diseases, the elderly, people in nursing homes, and people with little access to health care, such as the homeless, migrant farm workers, and the poor.

International travelers

The long-term use and misuse of antibiotics has caused many microorganisms to adapt to these drugs. Even antibiotics used to treat common bacterial infections are becoming ineffective; as a result, hospital stays are longer, health care costs are rising, and death rates are increasing. In recent years, new or increasing drug resistance has been discovered in organisms that cause malaria, TB, gonorrhea, meningitis, pneumonia, and ear infections. In addition, fewer new drugs are being developed, and our arsenal of effective drugs is diminishing.

Resistance to the Antibiotic Vancomycin in Enterococcal Infections* in U.S. Hospitals



*Enterococcal infections affect the intestines and can be life-threatening primarily for the very old and very sick.

Families and communities

Changes in dietary habits, food processing and packaging, and availability of food from all parts of the world are contributing to an increase in illnesses due to foodborne diseases. Emerging infections spread by contaminated foods and water supplies may place whole communities at risk.

- Hamburgers contaminated with E. coli O157:H7 and served at a fast-food restaurant chain caused a multistate outbreak of bloody diarrhea and serious kidney disease in 1993. More than 600 persons got sick, 56 had kidney failure, and 4 children died.
- Also in 1993, a municipal water supply contaminated with the intestinal parasite Cryptosporidium caused the largest recognized outbreak of waterborne illness in the history of the United States. Over400,000 people in Milwaukee, Wisconsin, had prolonged diarrhea, and approximately 4,400 were hospitalized. The number of deaths is still under investigation.

Children in day care facilities

Now numbering over 11 million, children in day care facilities are at a much greater risk for intestinal infections, respiratory illnesses, and middle ear infections. Office visits for childhood ear infections, the leading cause of visits to pediatricians, increased 150% between 1975 and 1990, to approximately 24 million per year. Many of these illnesses are carried home and are spread to other family members.

As Nobel Laureate Dr. Joshua Lederberg has stated, The microbe that felled one child in a distant continent yesterday can reach your child today and seed a global pandemic tomorrow.

Increased international travel brings diseases once considered exotic to our doorstep. Recently, 75 international airline passengers arriving in California became ill with choleraone died; residents of an affluent area of San Diego County, California, came down with malaria; and troops returning from the Persian Gulf conflict brought with them a potentially new form of the parasitic blood and bone marrow infection leishmaniasis. Influenza travels rapidly around the globe today.

Emerging infections can touch people everywhere, regardless of lifestyle, cultural or ethnic background, or socioeconomic status.

The Public Health Picture

The public health system of this country is not prepared for the emerging disease problems of a rapidly changing world. Current systems for keeping track of infectious diseases here and abroad cannot meet the threat of emerging infections. The nation's early warning system for infectious diseasesthe backbone of U.S. public health programs for more than a centuryis in disarray. Many foodborne and waterborne disease outbreaks go unrecognized or are detected late; drug resistance is not well understood; and global disease surveillance is rudimentary.

"In recent years, our antibiotics have become less effective against many infectious agents, and experts in infectious diseases are concerned about the possiblity of a 'post-antibiotic era.' At the same time, our ability to detect, contain, and prevent emerging infectious diseases is in jeopardy."

David Satcher, Director
Centers for Disease Control and Prevention

Return to CDC Homepage

researchers now knew that there was a new strain of E. coli that could get into food and make people seriously ill.

The Bacteria: A Virulent Strain Never Seen Before

Yet a fundamental question remained. How, or why, did these bacteria make people sick?

A crucial clue came from a seemingly unrelated investigation that was going on at the same time. Dr. Mohamed Karmali, who is the head of microbiology at the Hospital for Sick Children in Toronto, had been tormented over a mysterious illness. In 1980, in the space of 10 days, 14 children were admitted to his hospital, all with the same symptoms. Their illness began with diarrhea. About a week later, their kidneys failed. Two children died and others were left with severe, permanent damage to their kidneys and bowels.

Like Riley, Karmali and his colleagues asked what these children had in common. "There weren't too many leads," Karmali said. "We were looking at all sorts of poisons and chemicals." One hint, significant mainly in retrospect, was that the children had visited a farm market on the outskirts of Toronto and had drunk unpasteurized apple juice.

"I was working day and night," looking for **infectious** organisms that could have caused the strange illness, Karmali recalled. "Then we had sort of a break," he said. An 18-month-old boy died, and the autopsy showed that the boy had E. coli bacteria in his bowel that were making a potent, unidentified toxin.

Karmali began looking for the bacteria in the feces of children admitted later with the kidney **disease**, called hemolytic uremic syndrome, but could not find them, probably because the children's active diarrhea had already ended.

So Karmali searched for the toxin instead. "To our surprise, we found the toxin in the stool," he said.

Laboratory tests showed that the toxin killed monkey kidney cells and a type of human cell grown for research. That sounded familiar to Dr. Alison O'Brien, a microbiologist at the Uniformed Services University of the Health Sciences in Bethesda, Md., who heard about the research at a scientific meeting. She worked with a different bacterium, Shigella, that exudes a toxin with exactly the same properties. It could be, she reasoned, that the E. coli had picked up the gene that causes bacteria to make Shigella toxin. If so, the new E. coli was armed with "a nasty little toxin," Dr. O'Brien said -- indeed, probably the third most dangerous bacterial toxin known, coming right after tetanus and botulism.

Dr. O'Brien examined the rogue E. coli, and sure enough, discovered that it had somehow taken on the Shigella toxin gene. Moreover, in many of the E. coli, that gene was slightly altered in a way that made the bacterium produce toxin even more deadly than the original toxin made by Shigella.

No one knows exactly how the Shigella toxin genes jumped to E. coli, but Dr. O'Brien has an educated guess. Viruses that infect bacteria can sometimes pick up a gene from one bacterium and carry it to another.

But if that was the seminal event, Dr. O'Brien said, it probably did not occur in the United States, where Shigella bacteria do not have the dangerous toxin gene. Shigella in Central America do have that gene, however, and in the 1970s, that area was hit with a pandemic of Shigella dysentery. As the Shigella

mixed with harmless E. coli in people's intestines, or as it mixed with harmless E. coli that inhabited animal manure, a virus may have carried Shigella toxin genes to E. coli. The result would have been a strain that had never been seen before: the toxin-armed E. coli O157:H7.

However the toxin does its work -- and scientists still do not know for sure -- the result is that it can injure cells that line blood vessels, plugging them with blood clots. When this happens, the first symptom is bloody diarrhea. But a small proportion of people, especially young children and the elderly, develop hemolytic uremic syndrome, the actual destruction of the kidneys that occurs when blood vessels in these organs are destroyed. The syndrome can lead to kidney failure or can be fatal. Infections with E. coli O157:H7 are now the leading cause of kidney failure in children, the CDC says, with at least 1,000 children a year developing kidney failure from these infections, and 3 to 5 percent dying.

Older people also tend to develop another complication, thrombotic thrombocytopenic purpura, a sort of leakage of the blood vessels that feed nerve cells. The result is an encephalitis-like **disease**, with psychosis, comas or seizures.

The bacteria are surprisingly tough and virulent. For example, said Dr. Marguerite Neill, chief of the division of **infectious** diseases at Brown University School of Medicine, most bacteria do not produce **disease** unless a person is exposed to millions of them. But as few as 10 or so E. coli O157:H7 can produce illness -- far too few to see or smell.

While most bacteria, including botulism bacteria, cannot live in acidic environments, E. coli O157:H7 is undaunted, able to grow in foods like unpasteurized apple cider and commercial mayonnaise.

The Epidemics: From Dairy Cows to Food Supply

As researchers studied the organism and its effects, E. coli O157:H7 epidemics kept ticking away, usually going unreported because they were sporadic and few doctors thought to test for E. coli. But some outbreaks were hard to miss. In September 1984, 34 out of 101 people living in a Nebraska nursing home became ill with E. coli infections. They had eaten contaminated hamburgers.

In October 1988, 32 junior high school students from a school in Minneapolis developed bloody diarrhea from eating contaminated hamburgers in the school cafeteria.

Nonetheless, said Dr. James Marsden, a professor of meat science at Kansas State University, "other than among scientists, I don't think it really sank in what a serious issue this was until the Jack in the Box outbreak," in 1993, when four children died and hundreds of people became ill.

Ridding meat of the new E. coli strain became "the biggest challenge ever to face the industry," Marsden said.

Public health officials also changed their tack. The Centers for **Disease** Control made a video about E. coli O157:H7 and sent it to public laboratories, suggesting they look for the bacteria. Suddenly, the E. coli were everywhere.

"We used to recognize outbreaks every couple of years," said Dr. Griffin, the epidemiologist for the Center for **Disease** Control. "Now we see 25 to 30 a

year." And the list of foods that caused outbreaks keeps growing. "We look at that list and say, 'Wow,'" Dr. Griffin said.

But how, scientists asked, were the E. coli entering the food chain? Because the first outbreaks seemed to be associated with ground beef, scientists looked into cattle and other farm animals.

Initially, the scientists came up empty handed. In 1982, the Department of Agriculture could not find E. coli O157:H7 in any animals in the country, indicating that the infected cows that contaminated the McDonald's hamburgers must have been rarities. But now, said Dr. Michael Doyle, the director of the University of Georgia's Center for Food Safety and Quality Enhancement in Griffin, Ga., as many as 1.5 to 5 percent of dairy cows carry the organism. Dairy cows and other cattle seem to be the Typhoid Marys of the epidemics, carrying the bacteria harmlessly in their feces. From there, the bacteria enter the food supply. In modern meat plants, a single contaminated carcass can be ground up with scores of other cows to produce hamburgers.

E. coli O157:H7 has also gotten into apple cider, possibly because farmers fertilized their crops with cow manure, Doyle said. It has also gotten into lettuce and alfalfa sprouts.

Other animals can carry E. coli as well. Doyle said he helped investigate a case in Oregon where 11 family members got sick after eating venison jerky. The deer had been infected and the E. coli, he said, "survived the brine process."

He added, "There are reports of kids who went to petting zoos on farms and got sick from petting goats."

The outbreaks have pushed the government into revamping regulation of the food industry. Meat plants are starting to replace the decades-old "sniff and poke" system of inspection with high-tech microbial tests. The Clinton administration is seeking greater power to levy fines and order recalls.

The Food and Drug Administration recently approved irradiation for meat, a method that can kill E. coli. Non-irradiated hamburger, safety experts say, should be cooked until the inside reaches 155 degrees. They also advise thoroughly washing produce and avoiding raw milk and unpasteurized apple juice.

"I really credit the USDA and the FDA for new initiatives," said Dr. Michael Osterholm, an epidemiologist at the Department of Public Health in Minnesota who in summer 1996 traced an outbreak that sickened scores of children in a Twin Cities day-care center to a cow carcass one child's family had in their freezer. "But if you gave me all the money in the world, I'm not sure I could keep these bacteria out of the food supply."

That, however, is no excuse for complacency from regulators or the food industry, Dr. Griffin said.

"The bottom line should be, is it reasonable that if a consumer undercooks a hamburger that their 3-year-old child dies?" she asked. "Even if only a small number of children die each year, 50 or 100, I think it galls consumers and that's understandable. They are asking, Can't we have better control of how our food is produced?"

September 11, 1998

E. Coli Bacteria Can Be Eliminated From Cattle, Researchers Find

Related Article

- Beef Patties Are Recalled After E. coli Case (June 30)

By JANE E. BRODY

Microbiologists at Cornell University have found a way to virtually rid cattle of harmful strains of E. coli bacteria, including the bacteria that have caused scores of deaths and sickened thousands of consumers of undercooked hamburgers.

Their studies, described in Friday's issue of the journal Science, demonstrated that the grain-based feedlot diet usually fed to cattle before slaughter fosters the growth of E. coli bacteria, some of which can cause **disease**. Among the dangerous strains that can survive when cattle are fed grain is E. coli O157:H7, the most deadly E. coli known.

The findings were met with enthusiasm by both the cattle industry and food safety experts.

Agriculture Secretary Dan Glickman said in a statement, "This deceptively simple finding, if confirmed by further research, has the potential to greatly assist our efforts to fight food-borne illness."

Grain feeding helps make beef tender and fatty and is considered the most economical way to feed cattle before slaughter. But the researchers found that if cattle were switched to a diet of hay or fresh grass for five days before slaughter, the possibility of infection from meat contaminated with the deadly strain could all but be eliminated.

Dr. James Russell, an Agriculture Department microbiologist who teaches at Cornell, explained that when cattle ate grain, the acid level of their colon rose and fostered the growth of acid-resistant bacteria, which could include the highly virulent E. coli O157:H7. This organism could remain alive in the animal's fecal matter and accidentally contaminate meat during slaughter.

Acidity in the animal's colon, Russell said, "turns on E. coli's acid-resistant genes, which allows them to survive in the human stomach." Normally, stomach acid is an effective barrier to infection by food-borne pathogens because the organisms die in an acid environment.

Most cases of **infectious** food poisoning require consumption of about 10,000 microorganisms, but as few as 10 E. coli O157:H7 cells can make a person deathly ill, Russell said. The organism is made even more dangerous by its capacity to survive the journey through the acid juices in the human stomach.

Bacteria on the surface of meat are destroyed by the heat of cooking. But if the organisms get mixed into foods like hamburgers, they can survive the cooking process unless the meat is well done throughout. Other occasional sources of infection by E. coli O157:H7 are vegetables grown in fields fertilized by cattle manure, unpasteurized fruit juices and contaminated water from wells, lakes, water parks and swimming pools.

Dr. Robert Buchanan, a microbiologist at the Food and Drug Administration, said the proposed change in feeding could be "an extremely practical, cost-effective intervention" but also emphasized the need for further study.

E. coli are normal inhabitants of the human digestive tract, but only certain strains can cause illness. E. coli O157:H7 produces a toxin that attacks the gastrointestinal tract and can cause severe cramping, abdominal pain, watery or bloody diarrhea, vomiting or fever. It can also cause kidney failure, which is fatal in as many as 30 percent of cases.

In the Cornell studies, conducted by Dr. Francisco Diez-Gonsalez, Todd Callaway and Menas Kizoulis along with Russell, researchers showed that when cattle were fed grains until slaughter, the acid level rose in the colon enough to permit the growth of about 100 million E. coli cells, about a million of which were acid-resistant and able to withstand the acidity of the human stomach.

But when the animals were fed hay for just five days, only about 10,000 E. coli cells were present, and virtually none had the potential to become acid resistant, Russell said in an interview. The researchers wrote that "virtually all" the surviving bacteria were killed by a dose of acid comparable to what is found in the human stomach.

Russell said the colon contents of cattle became acidic on a diet of grain because the animals incompletely digested the starch in grains. This permits some starch to reach the colon where bacteria can ferment it and produce fermentation acids. But on a diet of hay, there is no residual starch to be fermented in the colon. Thus, the acid level remains low and the E. coli remain acid-sensitive. The result is a million-fold fewer acid-resistant E. coli cells in hay-fed cattle, the researchers found.

Russell pointed out that only a very small percentage of cattle -- "only about 1 to 2 percent" -- harbor the deadly E. coli, but that "when animals go to slaughter, no one knows which ones they are."

Dr. Gary Weber, executive director for regulatory affairs at the National Cattlemen's Beef Association in Washington called the findings "exciting and very promising," but added that further study was needed "to see how it might work in full-scale farm and ranch feeding systems" and whether other techniques might work on acidity.

If further research confirms the value of the early findings, the Department of Agriculture could recommend changes in the way the cattle are fed, but it now lacks the authority to mandate such a change, the association said.

Although it may seem easier to control E. coli infections by improving the hygiene in slaughter houses, Russell said that even in the most hygienic establishments it is nearly impossible to prevent all fecal contamination of meat.

In their journal report, the researchers noted that "because grain feeding promotes both the production and efficiency of cattle, it is unlikely that American cattle will ever be fed diets consisting only of hay." But, they added, based on their results "cattle could be given hay for a brief period immediately before slaughter to reduce the risk of food-borne E. coli infection."

Furthermore, this brief diet of hay "should not affect either carcass size or meat quality," said Dr. Donald Beermann, professor of animal science at Cornell. Beermann added that the dietary change would involve "minimal expense and inconvenience to feedlot operators."

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HIV/AIDS and influenza, as well as the reemergence of cholera as a global health threat -- consistent with a perspective that "the microbe that felled one child in a distant continent yesterday can reach yours today and seed a global pandemic tomorrow" (46). These examples underscore the fact that emerging infections can affect persons in geographically widespread areas, regardless of factors such as lifestyle, cultural or ethnic back- ground, or socioeconomic status.

Preparing to Confront Emerging Infections

The public health infrastructure is insufficiently prepared to confront today's emerging disease problems. Domestic surveillance systems for most infectious diseases are inadequate and global surveillance is fragmentary at best. For example, foodborne and waterborne disease outbreaks may be either unrecognized or detected late, and the magnitude of the problem of antimicrobial drug resistance is unknown.

Surveillance of infectious diseases in the United States depends on voluntary collaboration between CDC and state and local health departments, which depend on reporting by health-care professionals of a limited number of specific, recognized infectious diseases. Reporting is generally incomplete. Results of a recent survey conducted by the Council of State and Territorial Epidemiologists underscore the inadequacy of existing infectious disease surveillance by documenting the limited number of professional positions dedicated to infectious disease surveillance in most states. For example, in 12 of the 50 states surveyed, no professional position is dedicated to surveillance of foodborne and waterborne diseases. Funding for infectious disease surveillance is restricted primarily to diseases for which public health crises have already developed. In 1992, more than 95% of federal funds allocated to states for infectious disease surveillance were targeted to four disease categories (i.e., TB, HIV/AIDS, sexually transmitted diseases {STDs}, and selected vaccine-preventable diseases) (personal communication, M. Osterholm, Council of State and Territorial Epidemiologists survey on surveil- lance). However, no federal resources are provided to state and local health departments to support the national notifiable disease system. In addition, the ability of state public health laboratories to support the surveillance and control of infectious diseases has diminished (47).

Timely recognition of emerging infections requires early warning systems to detect such problems so they may be promptly investigated and controlled before they evolve into public health crises. Prompt detection of these new threats depends on careful monitoring by effective surveillance systems; on a thorough understanding of trends in incidence and distribution of known infectious agents; and on effective communication among clinicians, clinical laboratory personnel, and public health professionals.

The ability to detect what is new or reemerging depends on the capacity to identify and track both the routine and the unusual. Like radar or "early warning" systems that detect threats to national security, surveillance with appropriate laboratory support is a critical element in the effective defense against these diseases. Surveillance systems are the most important tools for determining which infectious diseases are emerging or receding.

Effective surveillance also provides a basis for evaluating the outcome of both public health and personal medical-care programs. Surveillance information is essential to ensure the use of the most efficacious and cost-effective approaches to preventive, as well as curative, health care. Regardless of the direction of health-care reform, surveillance will be critical to the meaningful evaluation of new prevention programs.

In addition to comprehensive and innovative surveillance systems, effective preparation for detecting, preventing, and controlling emerging infectious diseases requires sound foundations in profes- sional expertise, laboratory support, and research capability to strengthen the infrastructure needed to address the ongoing, but often changing, threats from emerging infections. Despite the continued emergence of such threats, support for applied research and control efforts has declined over the past decade.

Three recent reports by expert committees convened by the National Academy of Science's Institute of Medicine (IOM) have indi- cated that the ability of the U.S. public health system and health professionals to address emerging infectious disease problems is in jeopardy (3,48,49). The earliest of

these reports, "The U.S. Capacity to Address Tropical Infectious Disease Problems" (48), documented the inadequate state of readiness to recognize, treat, or control infectious disease threats emanating from the tropics -- regions that have yielded microbial threats such as Lassa fever and Ebola viruses, chloroquine-resistant malaria, and penicillin-resistant gonorrhea. The second report, "The Future of Public Health," concluded that the U.S. public health system is in disarray. This report emphasized that the U.S. approach to public health has too often been crisis driven, an approach that is costly because it constrains the institution of cost-saving preventive strategies (49).

The third IOM report, "Emerging Infections, Microbial Threats to Health in the United States," emphasized the ongoing threat to domestic and global health from emerging infectious diseases (3). The report provided specific recommendations for CDC, the National Institutes of Health, the Food and Drug Administration, the Department of Defense, and other federal and state agencies for addressing microbial threats to health in the United States and elsewhere. This report emphasized a critical leadership role for CDC in a national and global effort to detect and control emerging infectious disease threats.

THE CDC PREVENTION STRATEGY

To effectively detect and prevent emerging infections, improve- ments are needed in public health systems, program design, and infra- structure. To accomplish these improvements and to achieve the objectives of Healthy People 2000, CDC has developed a strategy to address these microbial threats. Because meeting the broad challenge of emerging infections requires interaction, cooperation, and coordination among a wide range of public and private organizations, the development of this strategy has taken place in partnership with state and local health departments, other federal agencies, academic institutions, health-care providers, medical laboratory personnel, and international organizations.

The prevention strategy outlined in this document contains four critical goals that address, in a broader context, specific IOM recom- mendations for revitalizing the ability to identify, contain, and, most importantly, prevent illness from emerging infectious diseases (Box 2 Table_B2).

Goal I (Surveillance) emphasizes the improvement and expansion of surveillance capabilities for infectious diseases in the United States and internationally. This goal includes plans for strengthening local and state public health programs for infectious disease surveillance, establishing provider-based sentinel surveillance networks, and creating population-based Emerging Infections Epidemiology and Prevention Centers at different sites throughout the United States (Table_2). Also included are plans for a global consortium of closely linked epidemiology/biomedical research centers to promote the detection, monitoring, and investigation of emerging infections (Box 3 Table_B3). Other objectives emphasize improved detection and monitoring of trends in antimicrobial resistance in both institutional and community settings; expansion of field investigations and epidemic response capabilities; prevention of foodborne and waterborne infectious diseases and improved knowledge of the distribution of animal reservoirs and vectors associated with human infectious diseases.

Goal II (Applied Research) focuses on applied research and the integration of laboratory science and epidemiology with public health practice. Emphasis is placed on determining how behavioral factors influence exposure to new infections; better characterizing the health burden of both well-established and emerging infections; and evalu- ating the effectiveness and economic benefit of strategies to prevent emerging infectious diseases. An additional focus is the development and application of improved laboratory techniques for the identifi- cation of new pathogens and the expanded use of molecular epidemio- logic techniques in investigating emerging diseases. Supporting the national Childhood Immunization Initiative by conducting vaccine efficacy studies and improving rapid response capabilities for vaccine development and delivery is also a priority. A final focus is the reestablishment of CDC extramural programs to promote effective partnerships with public agencies, universities, and private industry and to support applied research in surveillance, epidemiology, and prevention of emerging infections.

Goal III (Prevention and Control) addresses enhanced communi- cation of public health information and the implementation of prevention strategies for emerging infections. Highlighted under this goal are proposals for expanded dissemination of the MMWR, as well as other important public health

information sources. Another priority is the creation of an accessible and comprehensive infectious disease database for the United States that increases awareness of infectious diseases and promotes public health action. The database will contain current information on topics such as antimicrobial resistance, foodborne and waterborne disease outbreaks, travelers' health, antimicrobial drug availability, vaccine-preventable diseases, and vaccine guidelines. This goal also addresses the development and implementation of guidelines for preventing emerging infectious diseases and the provision of critical prevention materials.

Goal IV (Infrastructure) deals with issues relating to local, state, and federal infrastructure, particularly personnel and physical resources. Points of emphasis include maintaining expertise in rare or unusual infectious diseases and establishing training programs that emphasize the diagnosis of infectious diseases. A public health laboratory fellowship in infectious diseases is proposed. Also emphasized is the need for state-of-the-art physical resources such as laboratory space, training facilities, and equipment. Laboratory capabilities must be maintained in a manner that optimizes flexibility and "surge capacity" so that unanticipated public health threats can be adequately, efficiently, and safely addressed. Plans for expanding facilities for maintaining specimen banks of etiologic agents and clinical specimens are also a priority.

IMPLEMENTATION

This plan reflects CDC's commitment to meet the urgent public health challenge of important emerging infectious diseases. The need to proceed rapidly is made more urgent for many reasons. Many diseases pose an immediate danger. For example, methicillin-resistant Staphylococcus aureus, a common cause of hospital infections, may potentially develop resistance to vancomycin (29,50); penicillin resistance is spreading in Streptococcus pneumoniae (29,31,51); the potential exists for extension of the current cholera epidemic in Latin America to the Caribbean Islands (24); and Vibrio cholerae O139, a new strain for which existing cholera vaccines are ineffective and prior infection with V. cholerae O1 affords no protection, is spreading throughout southern Asia (Figure 5) (52,53). Changing food-industry practices, dietary choices, and globalization of food supplies will bring new challenges to provide a diet safe from pathogens such as Salmonella sp. and E. coli O157:H7 (37,38,54-57). Ongoing investigations of hantavirus pulmonary syndrome document that the geographic distribution of this infection goes beyond the desert Southwest (23). These infectious disease problems emphasize the necessity of expeditiously implementing this plan through a balanced intramural and extramural effort.

The implementation of the goals and objectives in this plan is relevant to health-care reform. Examples of relevant issues include prolonged hospitalizations caused by hospital-acquired infections; increased morbidity and treatment costs resulting from antimicrobial drug resistance; and excessive burdens placed on public and private health-care delivery facilities because of community-wide outbreaks of foodborne and waterborne infections.

Some of the activities listed in this document are already in the planning stages and will be implemented soon. Many of the proposed activities need further development in full cooperation with other federal agencies, state and local health authorities, academic insti- tutions, professional societies, private industry, and others. With this document serving as both a guide and a first step, implementation will be based on public health priorities and resource availability. This process will be approached in stages, as a long-term endeavor with sustainable impact and emphasis on extramural programs (Box 4 Table B4).

The strategy of this plan is based on repeated experience demon- strating that it is less costly to anticipate and prevent infectious disease threats than to react with expensive treatment or containment measures to public health crises. Public health policy and practice that combine investments in surveillance, laboratory research and training, and epidemiologic investigations with prevention and control efforts will reduce the impact of emerging infectious disease threats, in terms of both human suffering and economic losses.

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Development of this plan began in December 1992 with consultation from the Board of Scientific Counselors of CDC's National Center for Infectious Diseases. Further guidance was provided at a

meeting of infectious disease and public health experts in Atlanta in March 1993 and at a meeting of state and territorial public health epidemio- logists, laboratory directors, and veterinarians in Minneapolis in June 1993. Drafts of this plan have also been reviewed by leaders of numerous medical, scientific, and public health organizations.

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Table_B1

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

BOX 1. Examples of emerging infectious diseases, 1993

Diseases in the United States

-- Coccidioidomycosis
-- Cryptosporidiosis
-- Drug-resistant pneumococcal disease
-- Escherichia coli O157:H7 disease
-- Hantavirus pulmonary syndrome
-- Influenza A/Beijing/32/92
-- Vancomycin-resistant enterococcal infections

Diseases outside the United States

-- Cholera, Latin America
-- Dengue, Costa Rica
-- Diphtheria, Russia
-- E. coli O157:H7, South Africa and Swaziland
-- Multidrug-resistant Shigella dysenteriae, Burundi
-- Rift Valley fever, Egypt
-- Vibrio cholerae O139, Asia
-- Yellow fever, Kenya

Return to top.

Table_1

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

TABLE 1. Factors contributing to emergence of infectious diseases *

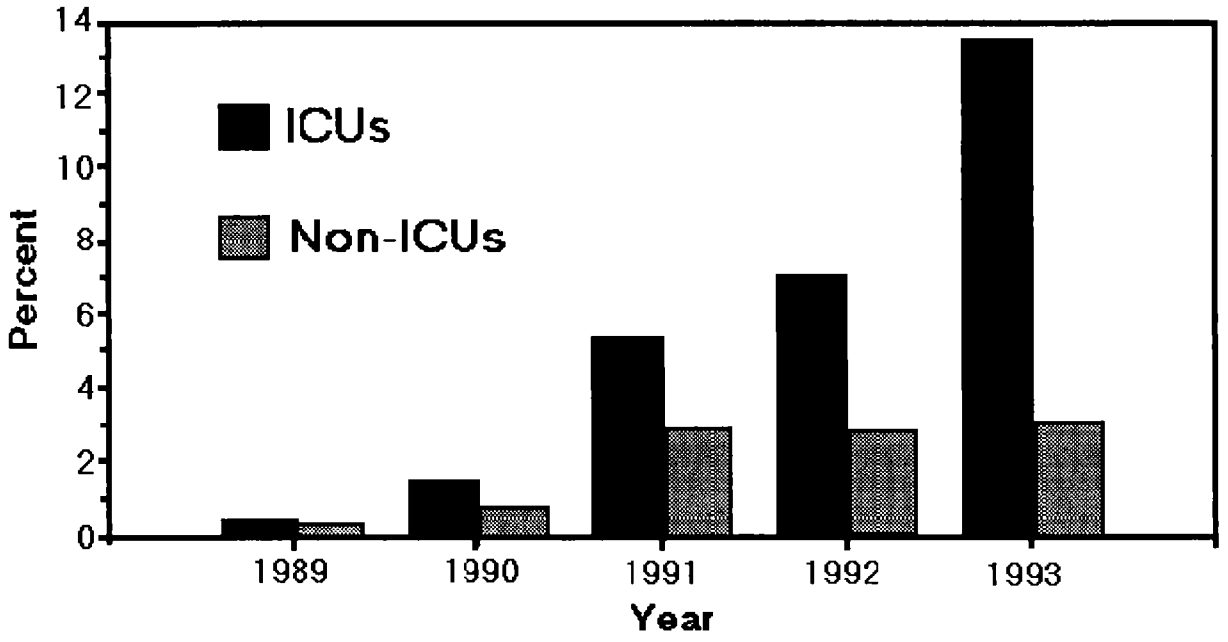
Categories	Specific examples
Societal events	Economic impoverishment; war or civil conflict; population growth and migration; urban decay
Health care	New medical devices; organ or tissue transplantation; drugs causing immunosuppression; widespread use of antibiotics
Food production	Globalization of food supplies; changes in food processing, packaging, and preparation
Human behavior	Sexual behavior; drug use; travel; diet; outdoor recreation; use of day care facilities
Environmental changes	Deforestation/reforestation; changes in water ecosystems; flood/drought; famine; global warming
Public health infrastructure	Curtailment or reduction of prevention programs; inadequate communicable disease surveillance; lack of trained personnel (e.g., epidemiologists, laboratory scientists, and vector and rodent control specialists)
Microbial adaptation and change	Changes in virulence and toxin production; development of drug resistance; microbes as cofactors in chronic diseases

* Adapted from reference 3.

Return to top.

Figure_1

FIGURE 1. Percentage of nosocomial enterococci reported as resistant to vanomycin isolated frm infections in patients in intensive-care units (ICUs) and non-ICUs, by year — National Nosocomial Infections Surveillance system, 1989-March 31, 1993 *

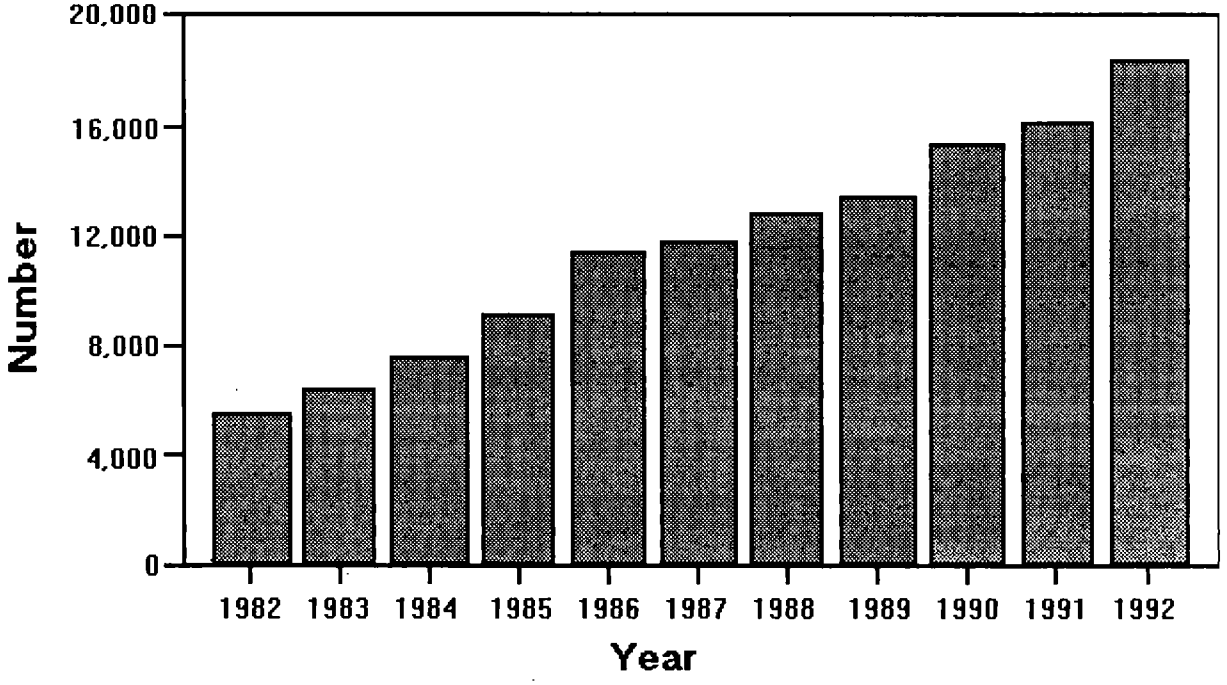


* Treatment options for patients with nosocomial infections associated with vancomycin-resistant enterococci are limited, often to unproven combinations fo antimicrobials or experimental compounds.

Return to top.

Figure_2

FIGURE 2. Number of organ transplants — United States, 1982-1992

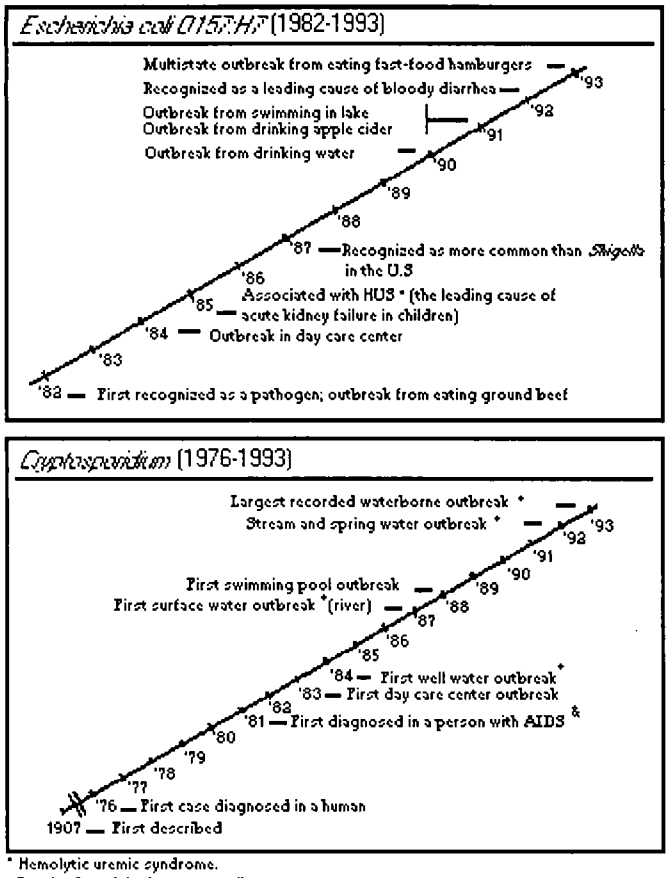


Source: United Network for Organ Sharing, Scientific Registry Data, July 23, 1993.

Return to top.

Figure_3

FIGURE 3. Emergence of foodborne and waterborne pathogens -- United States

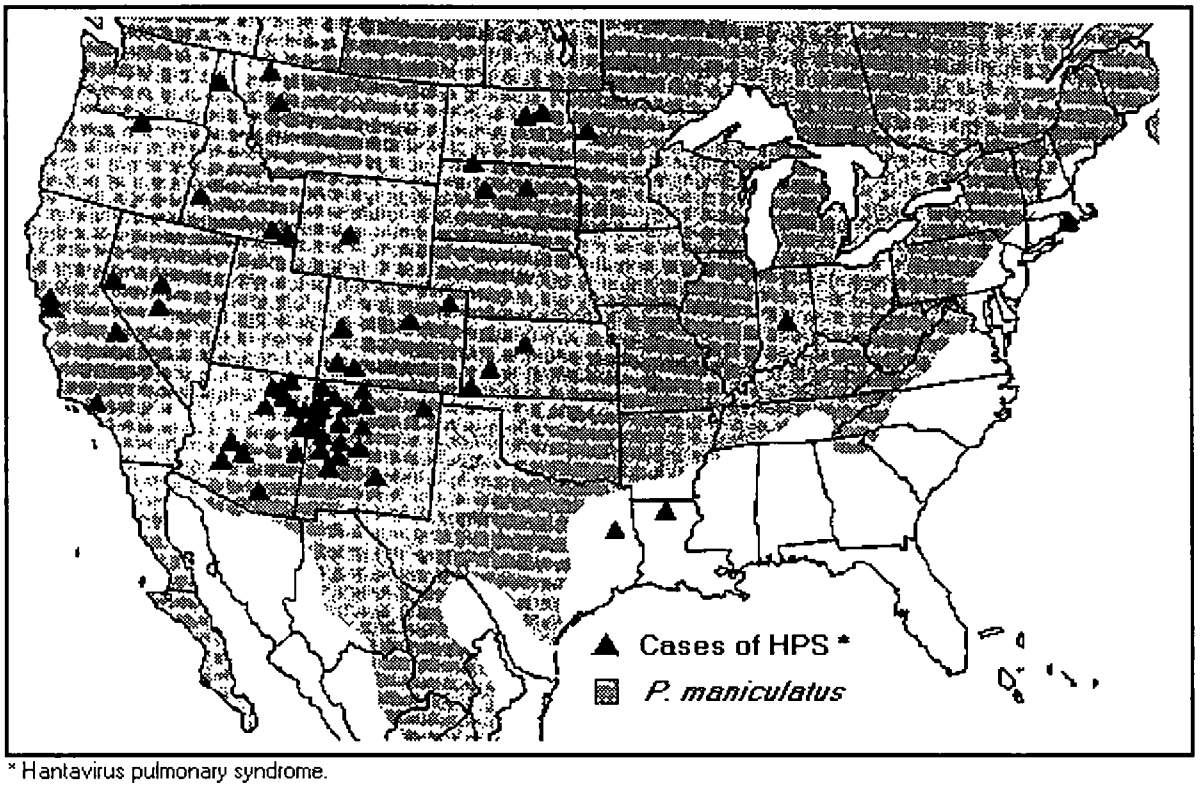


* Hemolytic uremic syndrome.
* Involved municipal water supplies.
& Acquired immunodeficiency syndrome.

Return to top.

Figure_4

FIGURE 4. Distribution of *Peromyscus maniculatus* and number of recognized cases of hantavirus pulmonary syndrome, selected geographic regions, as of March 23, 1994



* Hantavirus pulmonary syndrome.

Return to top.

Table_B2

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

BOX 2. Summary of goals and objectives for preventing illness from emerging infectious diseases

Goal I: Surveillance

Detect, promptly investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence.

Objectives:

-- Expand and coordinate surveillance systems for the early detection, tracking, and evaluation of emerging infections in the United States.
-- Develop more effective international surveillance networks for the anticipation, recognition, control, and prevention of emerging infectious diseases.
-- Improve surveillance and rapid laboratory identification to ensure early detection of antimicrobial resistance.
-- Strengthen and integrate programs to monitor and prevent emerging infections associated with food/water, new technology, and environmental sources.
-- Strengthen and integrate programs to monitor, control, and prevent emerging vector-borne and zoonotic diseases.

Goal II: Applied Research

Integrate laboratory science and epidemiology to optimize public health practice.

Objectives:

-- Expand epidemiologic and prevention effectiveness research.
-- Improve laboratory and epidemiologic techniques for the rapid identification of new pathogens and syndromes.
-- Ensure timely development, appropriate use, and availability of diagnostic tests and reagents.
-- Augment rapid response capabilities for vaccine production and delivery and expand evaluation of vaccine efficacy and the cost

effectiveness of vaccination programs.

Goal III: Prevention and Control

Enhance communication of public health information about emerging diseases and ensure prompt implementation of prevention strategies.

Objectives:

-- Use diverse communication methods for wider and more effective delivery of critical public health messages.
-- Establish the mechanisms and partnerships needed to ensure the rapid and effective development and implementation of prevention measures.

Goal IV: Infrastructure

Strengthen local, state, and federal public health infrastructures to support surveillance and implement prevention and control programs.

Objectives:

-- Ensure the ready availability of the professional expertise and support personnel needed to better understand, monitor, and control emerging infections.
-- Make available state-of-the-art physical resources (e.g., laboratory space, training facilities, and equipment) needed to safely and effectively support the preceding goals and objectives.

Return to top.

Table_2

To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

TABLE 2. Potential projects for Emerging Infections Epidemiology and Prevention Centers, United States

	Center Projects					
Potential center locations	Unexplained deaths of possible infectious etiology in young adults	Foodborne disease surveillance and prevention	Prevention of opportunistic infections in HIV- * infected inner-city populations	Drug resistance in nursing homes and day care facilities	Febrile and diarrheal illness in migrant farm workers	Etiologic agents of community-acquired pneumonia
Northeast	X	X	X			
Mid-Atlantic	X	X	X	X		X
Southeast	X	X	X		X	
South	X	X	X		X	X
Midwest	X	X		X	X	
Southwest	X	X		X		X
West	X	X	X	X	X	
Northwest	X	X		X	X	X
U.S. Pacific Islands	X	X				X
U.S. Caribbean Islands	X	X	X			

* Human immunodeficiency virus.

Return to top.

Table_B3

To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

BOX 3. Examples of potential members of a global consortium of epidemiology/biomedical research programs/centers

Existing networks

-- CDC Field Epidemiology Training Programs
-- International Clinical Epidemiology Network
-- International Office of Epizootics Worldwide Information System
-- Pan American Health Organization-CDC Dengue Surveillance Laboratory

```
    Network
--  Pan American Health Organization Polio Eradication Laboratory
    Surveillance Network
--  World Health Organization Arbovirus and Hemorrhagic Fever
    Collaborating Centers
--  World Health Organization Global Influenza Surveillance Network

Existing research facilities

--  Caribbean Epidemiology Centre, Trinidad
--  CDC: National Center for Infectious Diseases Field Stations (Cote
    d'Ivoire, Guatemala, Puerto Rico, Kenya, Sierra Leone, and Thailand)
--  Department of Defense: U.S. Army Research Facilities (Brazil, Kenya,
    Thailand) and U.S. Naval Research Facilities (Egypt, Indonesia, Peru,
    Philippines)
--  Food and Agriculture Organization Reference Centers (Argentina,
    Brazil, Colombia, Czech Republic, France, Germany, Hungary, Kenya,
    Panama, Senegal, Spain, Sri Lanka, Thailand, United Kingdom, Uruguay,
    and the United States)
--  French Scientific Research Institute (e.g., Senegal, Congo, Cote
    d'Ivoire)
--  Instituto de Nutricion para Centroamerica y Panama, Guatemala
--  International Center for Diarrhoeal Disease Research, Bangladesh
--  National Institutes of Health, National Institute of Allergy and
    Infectious Diseases-supported facilities (Brazil, Colombia, Israel,
    Mali, Mexico, Philippines, Sudan, Uganda, Venezuela, and Zimbabwe)
--  Pasteur Institutes (e.g., Algeria, Central African Republic, French
    Guiana, Iran, Madagascar, Morocco, New Caledonia, Senegal, and
    Vietnam)
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Return to top.

Table_B4

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

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BOX 4. Implementation: high priorities for 1994-1996

Goal I: Surveillance

--  Strengthen notifiable disease surveillance at state and local levels.
--  Establish two physician-based Sentinel Surveillance Networks to detect
    and monitor emerging diseases, such as unexplained adult respiratory
    distress syndrome, drug-resistant pneumococcal disease, and childhood
    illnesses characterized by fever and rash.
--  Establish four population-based Emerging Infections Epidemiology and
    Prevention Centers to conduct focused epidemiology/prevention projects
    emphasizing foodborne and waterborne infectious diseases and
    potentially vaccine-preventable diseases.
--  Strengthen and link four existing research facilities/networks for a
    global consortium to promote the detection, monitoring, and
    investigation of infections emerging internationally that could affect
    the health of U.S. residents.

Goal II: Applied Research

--  Reestablish an extramural program to support emerging infectious
    disease prevention and control activities, such as evaluating the role
    of prescribing practices in the development of antimicrobial
    drug-resistant pathogens.
--  Initiate prevention effectiveness studies to assess the impact of food
    preparation guidelines on the incidence of foodborne infections such
    as E. coli O157:H7 and Salmonella enteritidis.

Goal III: Prevention and Control

--  Develop additional means to deliver laboratory and public health
    information informing health professionals about emerging infections
    and antimicrobial drug resistance.
--  Develop and implement guidelines for the prevention of opportunistic
    infections in immunosuppressed persons.

Goal IV: Infrastructure

--  Provide state-of-the-art training in diagnostic evaluation and testing
    for medical laboratory personnel to ensure the diagnosis and surveil-
    lance of emerging infections.
--  Establish a public health laboratory fellowship in infectious diseases
    that will train medical microbiologists in public health approaches to
    diagnosis and molecular epidemiology.
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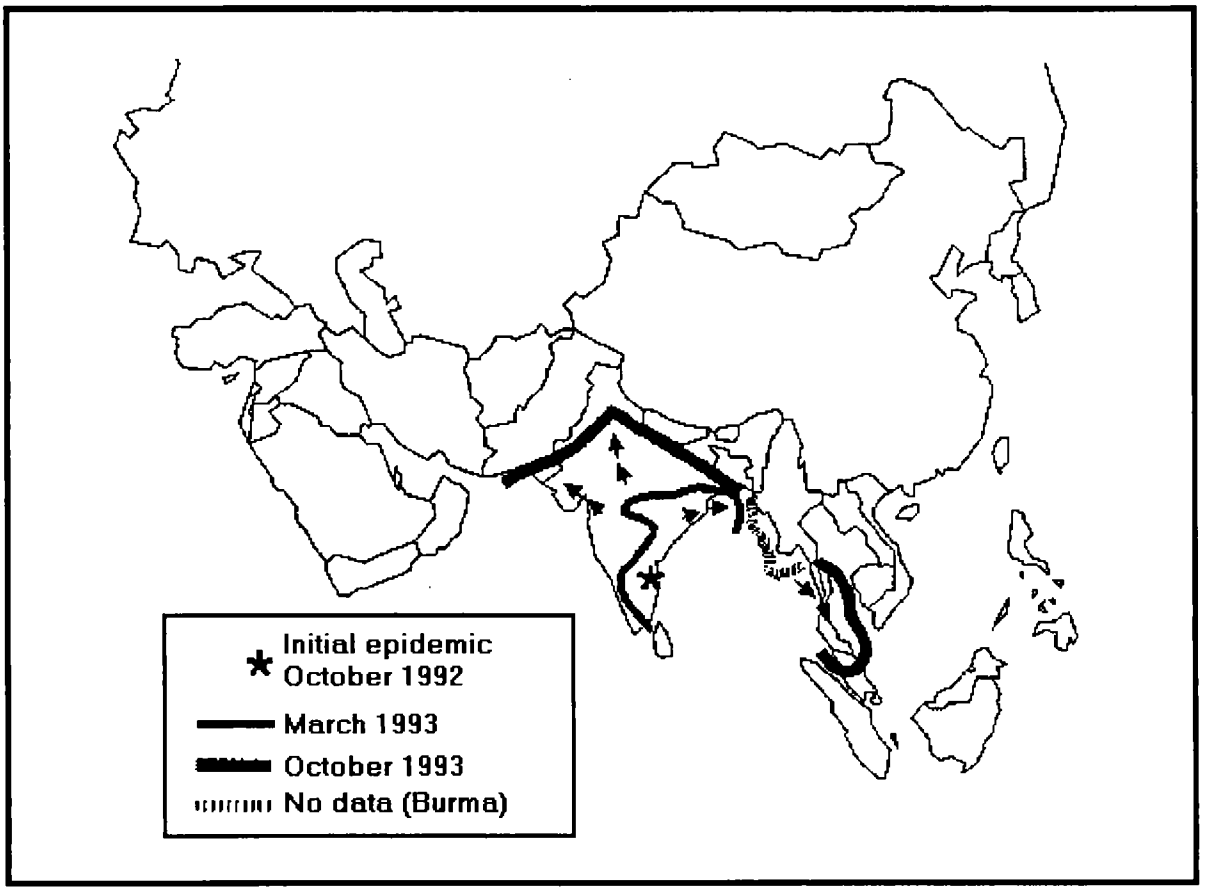
Return to top.

Figure_5

FIGURE 5. Migratory path of *Vibrio cholerae* O139 (Bengal) — Asia, 1992-1993



Return to top.

Return To: Search *MMWR* MMWR Home Page CDC Home Page

Appendix

Implementation of High Priority Activities from *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States* 1994–1997

In the 1994 plan, *Addressing Emerging Infectious Disease Threats: A Prevention Strategy for the United States,* CDC outlined 10 priority activities for the first years of the effort to combat emerging infectious diseases. This appendix describes the progress made in implementing those 10 activities. Additional CDC achievements in the area of emerging infectious diseases have been summarized elsewhere.[93,94]

Goal I: Surveillance and Response

Detect, investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence.

Priority I:
Strengthen notifiable disease surveillance at the state and local levels.

Implementation:

1995. Created the Epidemiologic and Laboratory Capacity (ELC) Cooperative Agreement Program to help states and large local and territorial health departments develop the core capacity to meet infectious disease threats (see page 17).

1995. Entered into ELC agreements with Colorado, Florida, Georgia, Kansas, Los Angeles County, Massachusetts, New Jersey, New York City, Washington State, and West Virginia.

1996. Entered into ELC agreements with Hawaii, Louisiana, Maine, New York State, and Pennsylvania.

1997. Entered into ELC agreements with Illinois, Michigan, Ohio, Tennessee, Utah, Vermont, and Wisconsin.

1997. Entered into a cooperative agreement with the Council of State and Territorial Epidemiologists (CSTE) to enhance state health departments' capacities to respond to outbreaks of unusual size, duration, or severity.

Priority 2:
Establish two physician-based sentinel surveillance networks to detect and monitor emerging diseases, such as

unexplained adult respiratory distress syndrome, multidrug-resistant pneumococcal disease, and childhood illnesses characterized by fever and rash.

Implementation:

1995. Established the Emergency Department Sentinel Network for Emerging Infections (EMERGEncy ID NET) (see page 19). The network is coordinated by the Olive View-UCLA Education and Research Institute.

1996. Established the Infectious Disease Society of America Emerging Infections Network (IDSA EIN), which includes over 500 infectious disease specialists practicing in 47 states, the District of Columbia, and Puerto Rico (see page 19). This network is coordinated by the Veterans Administration Medical Center in Portland, Oregon.

1996. Established the Sentinel Network of Travel Medicine Clinics (GeoSentinel), in collaboration with the International Society of Travel Medicine (see page 19). GeoSentinel is composed of 22 travel medicine clinics, located in the United States and other countries.

1996–1997. Established seven to eight sentinel surveillance projects per year to investigate such diseases as pneumonia, hepatitis, influenza, nosocomial infections, catheter-related infections, LaCrosse encephalitis, recurrent respiratory papillomatosis, Creutzfeldt-Jakob disease, and infections due to vancomycin- resistant enterococci, acyclovir-resistant genital herpes, and respiratory syncytial virus.

Priority 3:
Establish four population-based Emerging Infections Epidemiology and Prevention Centers to conduct focused epidemiology and prevention projects emphasizing foodborne and waterborne infectious diseases and diseases that are vaccine preventable.

Implementation:

1995. Created the Emerging Infections Programs (EIPs) see pages 17–18).

1995. Entered into EIP agreements with California, Connecticut, Minnesota, and Oregon.

1996. Entered into an EIP agreement with Georgia.

1996. Created the Foodborne Disease Active Surveillance Network (FoodNet), in collaboration with the EIP network, the U.S. Food and Drug Administration, and the U.S. Department of Agriculture, to monitor the burden and determine the causes of foodborne diseases in the United States (see page 19).

1997. Entered into EIP agreements with New York State and Maryland.

Priority 4:
Strengthen and link four existing sites for a global consortium to promote the detection, monitoring, and investigation of infections emerging internationally that could affect the health of Americans.

Implementation:

1994. Helped form the National Science and Technology Council's interagency Working Group on Emerging and Re-emerging Infectious Diseases, Committee on International Science, Engineering and Technology (CISET), chaired by the Director, CDC.

1995. Supported the development and passage of the 1995 World Health Assembly resolution that formed the basis for the WHO program on emerging diseases and led to the establishment of the Division of Emerging and Other Communicable Diseases Surveillance and Control (WHO/EMC).

1995. Assigned CDC staff to the WHO subregional office in Harare, Zimbabwe, to implement a program to improve preparedness for, and response to, epidemic diarrheal diseases in southern Africa.

1995–1997. Participated in interagency emerging infectious disease activities initiated under the following bilateral and multilateral forums:

- The Asian-Pacific Economic Cooperation (APEC)
- The Common Agenda with Japan
- The U.S.-Russia Commission on Economic and Technological Cooperation
- The U.S.-South Africa Binational Commission
- The Group of Eight Industrialized Nations
- The Transatlantic Agenda with the European Union
- U.S.-Mexico Binational Agreement

1996. Helped form the interagency CISET Emerging Infectious Disease Task Force (co-chaired by CDC and the White House Office of Science and Technology Policy) to implement the National Science and Technology Council report, *Infectious Disease–A Global Health Threat*[36] and the 1996 Presidential Decision Directive on Emerging Infectious Diseases.[37]

1996–1997. Conducted an exchange of scientists with Vietnam and prepared a feasibility study for establishing a field station there.

1996–1997. Enhanced the CDC field stations in Kenya and Guatemala.

1996–1997. Provided funds to enhance surveillance and response capacities at 23 WHO Collaborating Centers based

at CDC that address emerging infectious disease issues covered in this plan (see page 25).

1996–1997. Strengthened global surveillance for influenza by increasing the number of influenza surveillance sites in China from 6 to 12, training laboratorians from 14 countries in Latin America and the Caribbean, and providing resources for enhanced influenza surveillance in Russia.

1997. Assigned an epidemiologist to work at the Naval Medical Research Unit No. 3 (NAMRU-3) in Cairo.

Goal II: Applied Research

Integrate laboratory science and epidemiology to optimize public health practice.

Priority 1:
Reestablish an extramural research program to support emerging infectious disease prevention and control activities, such as evaluating the role of prescribing practices in the development of antimicrobial drug-resistant pathogens.

Implementation:

1996. Created extramural grant programs to support research on tickborne diseases and on preventing the spread of antimicrobial resistance.

1997. Created extramural grant programs to support research on heterosexual and household transmission of hepatitis C virus infection; the development of diagnostics for certain parasitic, bacterial, and sexually transmitted diseases; and the development of algorithms for the diagnosis and treatment of diarrheal diseases. A contract was established to evaluate the utility of human papillomavirus testing in screening protocols for cervical disease.

1996–1997. Provided support for a variety of collaborative projects with academic institutions, through cooperative agreements with the Minority Health Professionals Foundation, the Association of Schools of Public Health, and the Association of Teachers of Preventive Medicine. The projects included studies of bleeding disorders, respiratory illnesses in day care, and enteric infections in a rural minority community.

Priority 2:
Assess the impact of food preparation guidelines on the incidence of foodborne infections such as E. coli *O157:H7 and* Salmonella *Enteritidis.*

Implementation:

1996–1997. Conducted surveys at FoodNet sites to assess factors related to ascertainment of foodborne and waterborne illnesses. Questions under study included the following:

Which diagnostic tests are ordered for patients with enteric illnesses? Which laboratory tests are performed when a health-care provider sends a stool sample to a clinical laboratory?

1996–1997. Conducted case-control studies of *E. coli* O157 and *Salmonella* infections at five FoodNet sites to investigate the role of food-handling practices and other behavioral factors in the transmission of foodborne diseases.

1997. Established a memorandum of understanding with the Food and Drug Administration, the U.S. Department of Agriculture, the U.S. Department of Education, and the Partnership for Food Safety Education (which includes representatives of the food industry) to develop a program for public education in food safety.

Goal III: Prevention and Control

Enhance communication of public health information about emerging diseases and ensure prompt implementation of prevention strategies.

Priority 1:
Develop additional means to deliver laboratory and public health information on emerging infections and antimicrobial resistance.

Implementation:

1994. Established biweekly national teleconferences to share expertise on the prevention and control of cryptosporidiosis outbreaks, under the auspices of the CDC Working Group on Waterborne Cryptosporidiosis.

1995. Created new outlets for the dissemination of public health information, including

• A new scientific journal called *Emerging Infectious Diseases*.

• On-line dissemination of surveillance data via the CDC Internet home page.

• Slide sets with technical notes on emerging infectious diseases for use by public health professionals.

1995–1997. Supported a series of forums on emerging infectious diseases conducted by the Institute of Medicine of the National Academy of Sciences, as well as several other conferences and scientific meetings on emerging infections.

1995–1997. Sponsored teleconferences for health professionals on such topics as hantavirus pulmonary syndrome, *E. coli* O157, vancomycin-resistant enterococci, and management of pneumococcal pneumonia.

1996. Developed a National Infectious Disease Prevention Training Plan in conjunction with the Association of State

and Territorial Directors of Health Promotion and Public Health Education (ASTDHPPE).

1996–1997. With the French agencies ORSTOM (Office de la Recherche Scientifique et Technique Outre-mer) and CNRS (Centre National de la Recherche Scientifique), as well as several other partners, CDC developed and sponsored the 1996 and 1997 International Workshops on Molecular Epidemiology and Evolutionary Genetics in Infectious Diseases.

1996–1997. Implemented a wide range of health education projects, including an Internet-based laboratory training program on drug-resistant gonorrhea and a program to educate pet owners about prevention of reptile-associated salmonellosis. CDC also created exhibits on dengue for a children's museum in Puerto Rico and conducted focus group research to develop a manual on infectious disease prevention issues for caretakers of older adults.

1997. Strengthened national education efforts on hepatitis-related liver disease (with an initial emphasis on infection with hepatitis C virus) by supporting efforts of private organizations, producing a teleconference, and providing training and educational materials.

1997. Created a public education campaign to improve communication between the public and physicians concerning *Helicobacter pylori* and ulcers.

1997. Published *The CAUSE: Careful Antibiotic Use to Prevent Resistance*, a newsletter for clinicians, public health workers, and others.

1997. Published *Cryptosporidium and Water: A Public Health Handbook* and conducted a teleconference on this topic for state and local health authorities, water utility workers, and others.

1997. Planned the International Conference on Emerging Infectious Diseases, held in Atlanta, Georgia, in March 1998.

Priority 2:
Develop and implement guidelines for the prevention of opportunistic infections in immunosuppressed persons.

Implementation:

1995. Published *Guidelines for the Prevention of Opportunistic Infections in HIV-Infected Persons* by the U.S. Public Health Service and the Infectious Diseases Society of America. These guidelines were published in CDC's *Morbidity and Mortality Weekly Report* (*MMWR*) and other medical journals and newsletters, and are available on the Internet.

1996. Initiated work on guidelines for the prevention of opportunistic infections in bone marrow transplant

recipients.

1997. Updated the 1995 *Guidelines for the Prevention of Opportunistic Infections in HIV-Infected Persons* and published them in the *MMWR* and other medical journals.

Goal IV: Infrastructure and Training

Strengthen local, state, and federal public health infrastructures to support surveillance and implement prevention and control programs.

Priority 1:

Provide state-of-the-art training in diagnostic evaluation and testing for medical laboratory personnel to ensure the diagnosis and surveillance of emerging infections.

Implementation:

1995–1996. Transferred rapid diagnostic techniques for diagnosis of hantavirus pulmonary syndrome and arboviral diseases (such as LaCrosse encephalitis, St. Louis encephalitis, and Venezuelan equine encephalitis) to state and local health departments.

1995–1997. Supported projects to improve diagnostic capacity at state and major metropolitan area health departments, through ELC agreements, EIPs, and other cooperative agreements. For example, funds were provided to eight states in 1996 and five states in 1997 through ELC agreements to implement standardized DNA fingerprinting of *E. coli* O157:H7 in state public health laboratories.

1995–1997. Supported intramural projects to improve diagnostic capacity at CDC's National Center for Infectious Diseases, providing laboratorians with advanced training, and purchasing state-of-the-art laboratory equipment and computer tools.

1996. Supported 75 new full-time positions at the National Center for Infectious Diseases, including laboratory scientists and technicians.

1996. Worked with the Pan American Health Organization to provide training in the diagnosis of influenza, dengue, and dengue hemorrhagic fever to support active surveillance for these diseases in the Americas.

Priority 2:

Establish a public health laboratory fellowship in infectious diseases that will train medical microbiologists in public health approaches to diagnosis and molecular epidemiology.

1995. Created the Emerging Infectious Diseases Laboratory Fellowship Program through a cooperative agreement with the Association of Public Health Laboratories (APHL) (see page 40). Of the 18 fellows who completed the program as of February 1998, two entered Ph.D. degree programs, two

entered master's degree programs, six accepted positions at CDC laboratories, five accepted positions at state public health laboratories, one accepted a position with a clinical microbiology laboratory, and one accepted a fellowship with the U.S. Department of Agriculture.

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URL: http://www.cdc.gov/ncidod/emergplan/27appendix.htm
Updated: 12/18/98 16:29:04

these reports, "The U.S. Capacity to Address Tropical Infectious Disease Problems" (48), documented the inadequate state of readiness to recognize, treat, or control infectious disease threats emanating from the tropics -- regions that have yielded microbial threats such as Lassa fever and Ebola viruses, chloroquine-resistant malaria, and penicillin-resistant gonorrhea. The second report, "The Future of Public Health," concluded that the U.S. public health system is in disarray. This report emphasized that the U.S. approach to public health has too often been crisis driven, an approach that is costly because it constrains the institution of cost-saving preventive strategies (49).

The third IOM report, "Emerging Infections, Microbial Threats to Health in the United States," emphasized the ongoing threat to domestic and global health from emerging infectious diseases (3). The report provided specific recommendations for CDC, the National Institutes of Health, the Food and Drug Administration, the Department of Defense, and other federal and state agencies for addressing microbial threats to health in the United States and elsewhere. This report emphasized a critical leadership role for CDC in a national and global effort to detect and control emerging infectious disease threats.

THE CDC PREVENTION STRATEGY

To effectively detect and prevent emerging infections, improve- ments are needed in public health systems, program design, and infra- structure. To accomplish these improvements and to achieve the objectives of Healthy People 2000, CDC has developed a strategy to address these microbial threats. Because meeting the broad challenge of emerging infections requires interaction, cooperation, and coordination among a wide range of public and private organizations, the development of this strategy has taken place in partnership with state and local health departments, other federal agencies, academic institutions, health-care providers, medical laboratory personnel, and international organizations.

The prevention strategy outlined in this document contains four critical goals that address, in a broader context, specific IOM recom- mendations for revitalizing the ability to identify, contain, and, most importantly, prevent illness from emerging infectious diseases (Box 2 Table_B2).

Goal I (Surveillance) emphasizes the improvement and expansion of surveillance capabilities for infectious diseases in the United States and internationally. This goal includes plans for strengthening local and state public health programs for infectious disease surveillance, establishing provider-based sentinel surveillance networks, and creating population-based Emerging Infections Epidemiology and Prevention Centers at different sites throughout the United States (Table_2). Also included are plans for a global consortium of closely linked epidemiology/biomedical research centers to promote the detection, monitoring, and investigation of emerging infections (Box 3 Table_B3). Other objectives emphasize improved detection and monitoring of trends in antimicrobial resistance in both institutional and community settings; expansion of field investigations and epidemic response capabilities; prevention of foodborne and waterborne infectious diseases and improved knowledge of the distribution of animal reservoirs and vectors associated with human infectious diseases.

Goal II (Applied Research) focuses on applied research and the integration of laboratory science and epidemiology with public health practice. Emphasis is placed on determining how behavioral factors influence exposure to new infections; better characterizing the health burden of both well-established and emerging infections; and evalu- ating the effectiveness and economic benefit of strategies to prevent emerging infectious diseases. An additional focus is the development and application of improved laboratory techniques for the identifi- cation of new pathogens and the expanded use of molecular epidemio- logic techniques in investigating emerging diseases. Supporting the national Childhood Immunization Initiative by conducting vaccine efficacy studies and improving rapid response capabilities for vaccine development and delivery is also a priority. A final focus is the reestablishment of CDC extramural programs to promote effective partnerships with public agencies, universities, and private industry and to support applied research in surveillance, epidemiology, and prevention of emerging infections.

Goal III (Prevention and Control) addresses enhanced communi- cation of public health information and the implementation of prevention strategies for emerging infections. Highlighted under this goal are proposals for expanded dissemination of the MMWR, as well as other important public health

information sources. Another priority is the creation of an accessible and comprehensive infectious disease database for the United States that increases awareness of infectious diseases and promotes public health action. The database will contain current information on topics such as antimicrobial resistance, foodborne and waterborne disease outbreaks, travelers' health, antimicrobial drug availability, vaccine-preventable diseases, and vaccine guidelines. This goal also addresses the development and implementation of guidelines for preventing emerging infectious diseases and the provision of critical prevention materials.

Goal IV (Infrastructure) deals with issues relating to local, state, and federal infrastructure, particularly personnel and physical resources. Points of emphasis include maintaining expertise in rare or unusual infectious diseases and establishing training programs that emphasize the diagnosis of infectious diseases. A public health laboratory fellowship in infectious diseases is proposed. Also emphasized is the need for state-of-the-art physical resources such as laboratory space, training facilities, and equipment. Laboratory capabilities must be maintained in a manner that optimizes flexibility and "surge capacity" so that unanticipated public health threats can be adequately, efficiently, and safely addressed. Plans for expanding facilities for maintaining specimen banks of etiologic agents and clinical specimens are also a priority.

IMPLEMENTATION

This plan reflects CDC's commitment to meet the urgent public health challenge of important emerging infectious diseases. The need to proceed rapidly is made more urgent for many reasons. Many diseases pose an immediate danger. For example, methicillin-resistant Staphylococcus aureus, a common cause of hospital infections, may potentially develop resistance to vancomycin (29,50); penicillin resistance is spreading in Streptococcus pneumoniae (29,31,51); the potential exists for extension of the current cholera epidemic in Latin America to the Caribbean Islands (24); and Vibrio cholerae O139, a new strain for which existing cholera vaccines are ineffective and prior infection with V. cholerae O1 affords no protection, is spreading throughout southern Asia (Figure_5) (52,53). Changing food-industry practices, dietary choices, and globalization of food supplies will bring new challenges to provide a diet safe from pathogens such as Salmonella sp. and E. coli O157:H7 (37,38,54-57). Ongoing investigations of hantavirus pulmonary syndrome document that the geographic distribution of this infection goes beyond the desert Southwest (23). These infectious disease problems emphasize the necessity of expeditiously implementing this plan through a balanced intramural and extramural effort.

The implementation of the goals and objectives in this plan is relevant to health-care reform. Examples of relevant issues include prolonged hospitalizations caused by hospital-acquired infections; increased morbidity and treatment costs resulting from antimicrobial drug resistance; and excessive burdens placed on public and private health-care delivery facilities because of community-wide outbreaks of foodborne and waterborne infections.

Some of the activities listed in this document are already in the planning stages and will be implemented soon. Many of the proposed activities need further development in full cooperation with other federal agencies, state and local health authorities, academic insti- tutions, professional societies, private industry, and others. With this document serving as both a guide and a first step, implementation will be based on public health priorities and resource availability. This process will be approached in stages, as a long-term endeavor with sustainable impact and emphasis on extramural programs (Box 4 Table_B4).

The strategy of this plan is based on repeated experience demon- strating that it is less costly to anticipate and prevent infectious disease threats than to react with expensive treatment or containment measures to public health crises. Public health policy and practice that combine investments in surveillance, laboratory research and training, and epidemiologic investigations with prevention and control efforts will reduce the impact of emerging infectious disease threats, in terms of both human suffering and economic losses.

Acknowledgments

Development of this plan began in December 1992 with consultation from the Board of Scientific Counselors of CDC's National Center for Infectious Diseases. Further guidance was provided at a

meeting of infectious disease and public health experts in Atlanta in March 1993 and at a meeting of state and territorial public health epidemio- logists, laboratory directors, and veterinarians in Minneapolis in June 1993. Drafts of this plan have also been reviewed by leaders of numerous medical, scientific, and public health organizations.

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Table_B1

HIV/AIDS and influenza, as well as the reemergence of cholera as a global health threat -- consistent with a perspective that "the microbe that felled one child in a distant continent yesterday can reach yours today and seed a global pandemic tomorrow" (46). These examples underscore the fact that emerging infections can affect persons in geographically widespread areas, regardless of factors such as lifestyle, cultural or ethnic back- ground, or socioeconomic status.

Preparing to Confront Emerging Infections

The public health infrastructure is insufficiently prepared to confront today's emerging disease problems. Domestic surveillance systems for most infectious diseases are inadequate and global surveillance is fragmentary at best. For example, foodborne and waterborne disease outbreaks may be either unrecognized or detected late, and the magnitude of the problem of antimicrobial drug resistance is unknown.

Surveillance of infectious diseases in the United States depends on voluntary collaboration between CDC and state and local health departments, which depend on reporting by health-care professionals of a limited number of specific, recognized infectious diseases. Reporting is generally incomplete. Results of a recent survey conducted by the Council of State and Territorial Epidemiologists underscore the inadequacy of existing infectious disease surveillance by documenting the limited number of professional positions dedicated to infectious disease surveillance in most states. For example, in 12 of the 50 states surveyed, no professional position is dedicated to surveillance of foodborne and waterborne diseases. Funding for infectious disease surveillance is restricted primarily to diseases for which public health crises have already developed. In 1992, more than 95% of federal funds allocated to states for infectious disease surveillance were targeted to four disease categories (i.e., TB, HIV/AIDS, sexually transmitted diseases {STDs}, and selected vaccine-preventable diseases) (personal communication, M. Osterholm, Council of State and Territorial Epidemiologists survey on surveil- lance). However, no federal resources are provided to state and local health departments to support the national notifiable disease system. In addition, the ability of state public health laboratories to support the surveillance and control of infectious diseases has diminished (47).

Timely recognition of emerging infections requires early warning systems to detect such problems so they may be promptly investigated and controlled before they evolve into public health crises. Prompt detection of these new threats depends on careful monitoring by effective surveillance systems; on a thorough understanding of trends in incidence and distribution of known infectious agents; and on effective communication among clinicians, clinical laboratory personnel, and public health professionals.

The ability to detect what is new or reemerging depends on the capacity to identify and track both the routine and the unusual. Like radar or "early warning" systems that detect threats to national security, surveillance with appropriate laboratory support is a critical element in the effective defense against these diseases. Surveillance systems are the most important tools for determining which infectious diseases are emerging or receding.

Effective surveillance also provides a basis for evaluating the outcome of both public health and personal medical-care programs. Surveillance information is essential to ensure the use of the most efficacious and cost-effective approaches to preventive, as well as curative, health care. Regardless of the direction of health-care reform, surveillance will be critical to the meaningful evaluation of new prevention programs.

In addition to comprehensive and innovative surveillance systems, effective preparation for detecting, preventing, and controlling emerging infectious diseases requires sound foundations in profes- sional expertise, laboratory support, and research capability to strengthen the infrastructure needed to address the ongoing, but often changing, threats from emerging infections. Despite the continued emergence of such threats, support for applied research and control efforts has declined over the past decade.

Three recent reports by expert committees convened by the National Academy of Science's Institute of Medicine (IOM) have indi- cated that the ability of the U.S. public health system and health professionals to address emerging infectious disease problems is in jeopardy (3,48,49). The earliest of

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

BOX 1. Examples of emerging infectious diseases, 1993

Diseases in the United States

-- Coccidioidomycosis
-- Cryptosporidiosis
-- Drug-resistant pneumococcal disease
-- Escherichia coli O157:H7 disease
-- Hantavirus pulmonary syndrome
-- Influenza A/Beijing/32/92
-- Vancomycin-resistant enterococcal infections

Diseases outside the United States

-- Cholera, Latin America
-- Dengue, Costa Rica
-- Diphtheria, Russia
-- E. coli O157:H7, South Africa and Swaziland
-- Multidrug-resistant Shigella dysenteriae, Burundi
-- Rift Valley fever, Egypt
-- Vibrio cholerae O139, Asia
-- Yellow fever, Kenya

Return to top.

Table_1

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

TABLE 1. Factors contributing to emergence of infectious diseases *

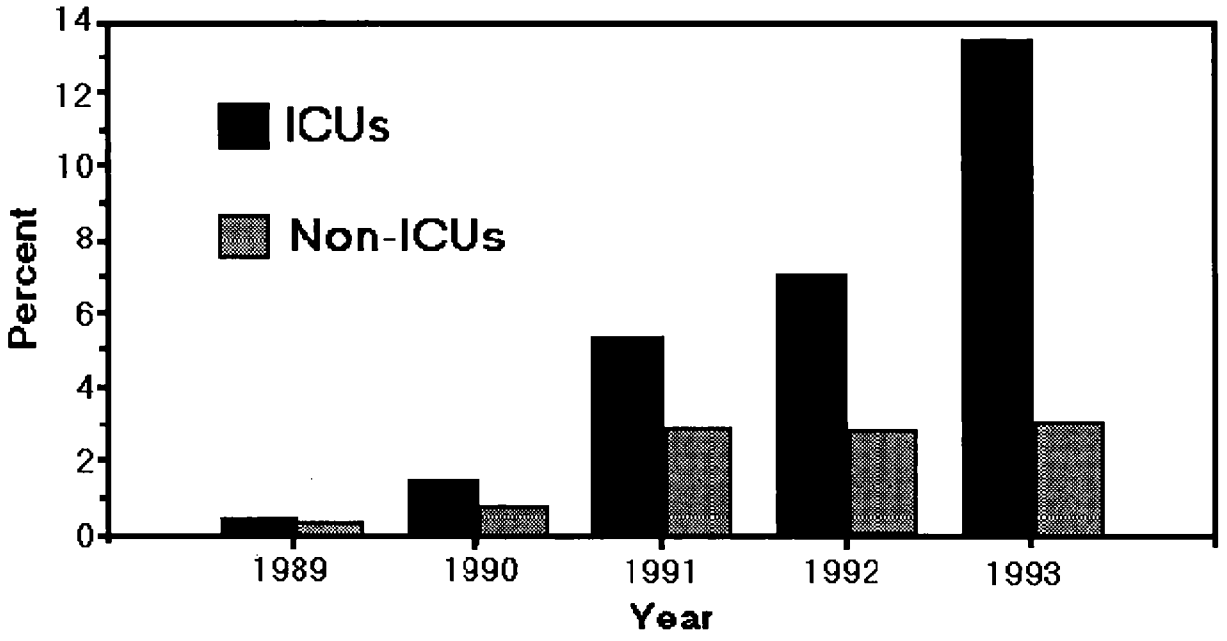
Categories	Specific examples
Societal events	Economic impoverishment; war or civil conflict; population growth and migration; urban decay
Health care	New medical devices; organ or tissue transplantation; drugs causing immunosuppression; widespread use of antibiotics
Food production	Globalization of food supplies; changes in food processing, packaging, and preparation
Human behavior	Sexual behavior; drug use; travel; diet; outdoor recreation; use of day care facilities
Environmental changes	Deforestation/reforestation; changes in water ecosystems; flood/drought; famine; global warming
Public health infrastructure	Curtailment or reduction of prevention programs; inadequate communicable disease surveillance; lack of trained personnel (e.g., epidemiologists, laboratory scientists, and vector and rodent control specialists)
Microbial adaptation and change	Changes in virulence and toxin production; development of drug resistance; microbes as cofactors in chronic diseases

* Adapted from reference 3.

Return to top.

Figure_1

FIGURE 1. Percentage of nosocomial enterococci reported as resistant to vanomycin isolated frm infections in patients in intensive-care units (ICUs) and non-ICUs, by year — National Nosocomial Infections Surveillance system, 1989-March 31, 1993 *

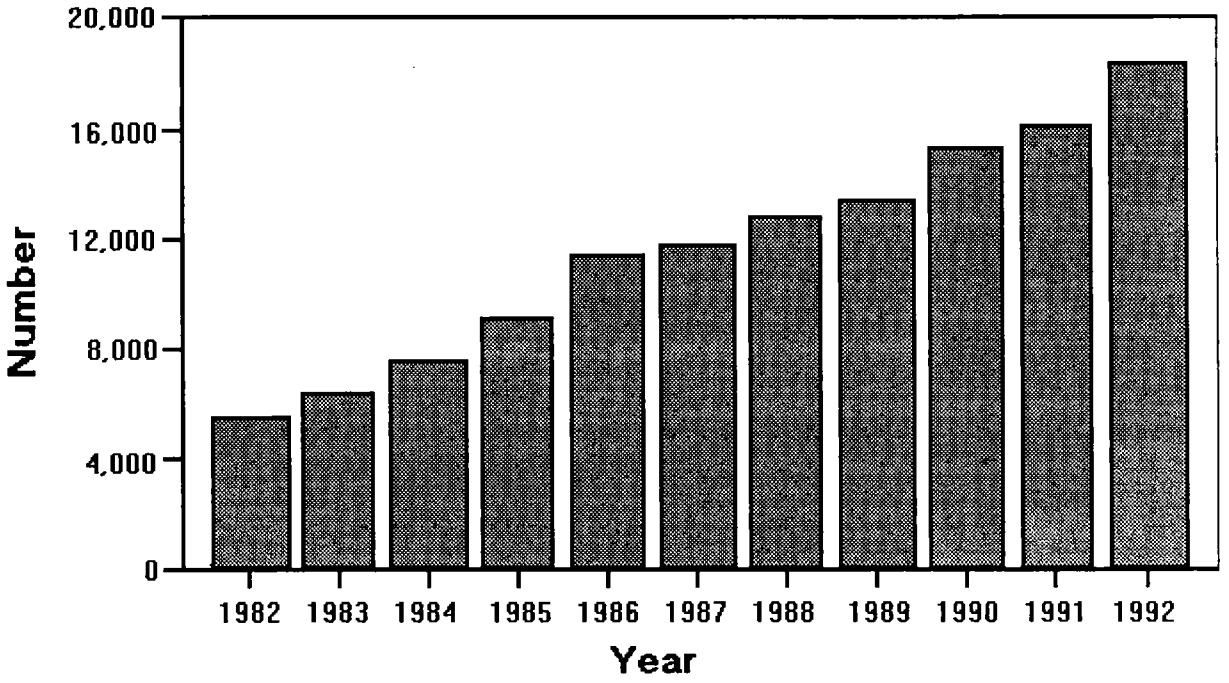


* Treatment options for patients with nosocomial infections associated with vancomycin-resistan enterococci are limited, often to unproven combinations fo antimicrobials or experimental compounds.

Return to top.

Figure_2

FIGURE 2. Number of organ transplants — United States, 1982-1992

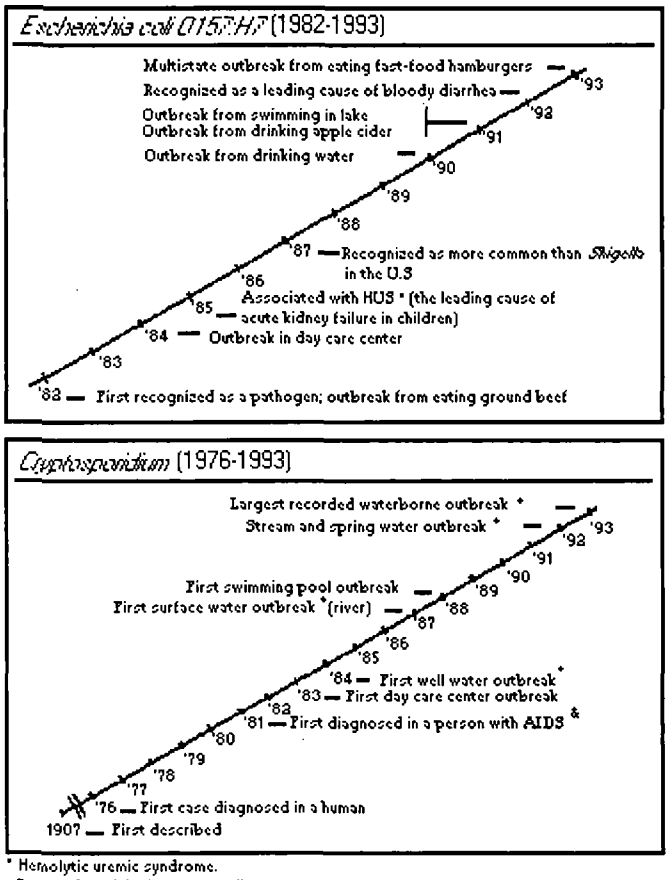


Source: United Network for Organ Sharing, Scientific Registry Data, July 23, 1993.

Return to top.

Figure_3

FIGURE 3. Emergence of foodborne and waterborne pathogens -- United States

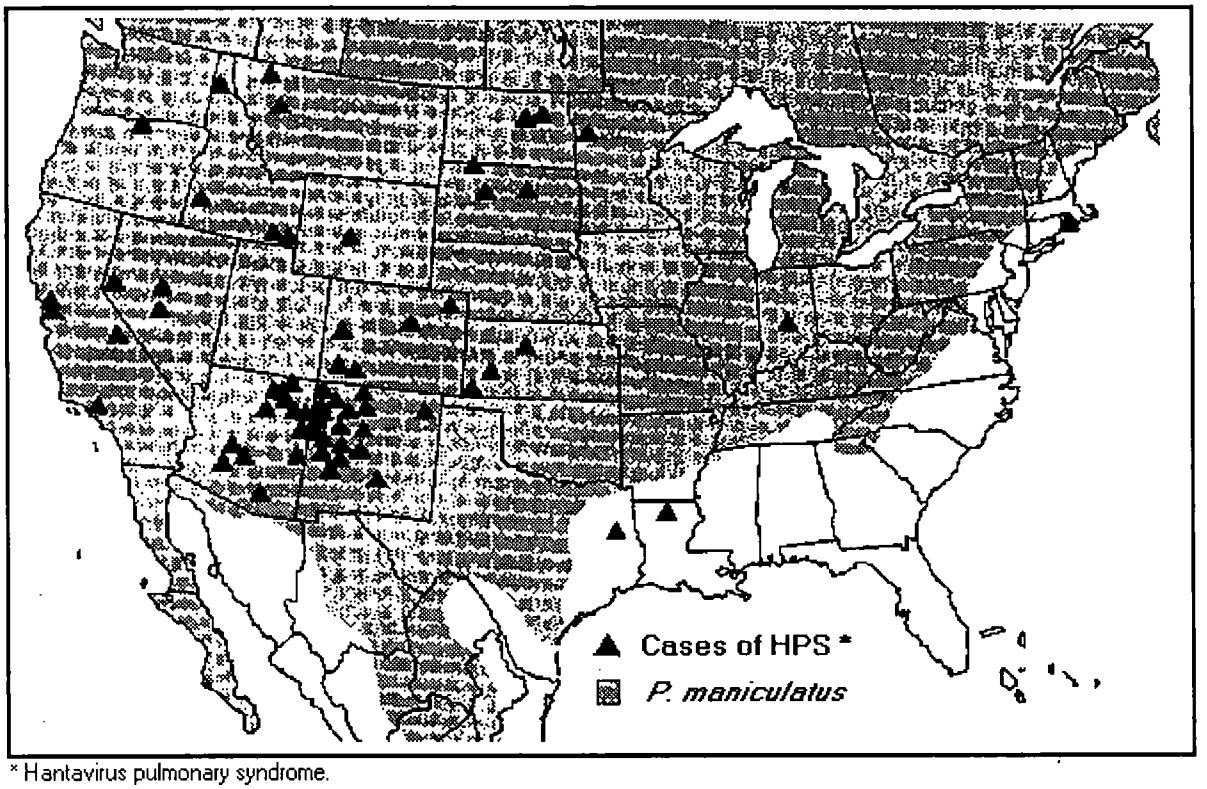


* Hemolytic uremic syndrome.
+ Involved municipal water supplies.
& Acquired immunodeficiency syndrome.

Return to top.

Figure_4

FIGURE 4. Distribution of *Peromyscus maniculatus* and number of recognized cases of hantavirus pulmonary syndrome, selected geographic regions, as of March 23, 1994



* Hantavirus pulmonary syndrome.

Return to top.

Table_B2

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BOX 2. Summary of goals and objectives for preventing illness from emerging infectious diseases

Goal I: Surveillance

Detect, promptly investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence.

Objectives:

-- Expand and coordinate surveillance systems for the early detection, tracking, and evaluation of emerging infections in the United States.
-- Develop more effective international surveillance networks for the anticipation, recognition, control, and prevention of emerging infectious diseases.
-- Improve surveillance and rapid laboratory identification to ensure early detection of antimicrobial resistance.
-- Strengthen and integrate programs to monitor and prevent emerging infections associated with food/water, new technology, and environmental sources.
-- Strengthen and integrate programs to monitor, control, and prevent emerging vector-borne and zoonotic diseases.

Goal II: Applied Research

Integrate laboratory science and epidemiology to optimize public health practice.

Objectives:

-- Expand epidemiologic and prevention effectiveness research.
-- Improve laboratory and epidemiologic techniques for the rapid identification of new pathogens and syndromes.
-- Ensure timely development, appropriate use, and availability of diagnostic tests and reagents.
-- Augment rapid response capabilities for vaccine production and delivery and expand evaluation of vaccine efficacy and the cost

effectiveness of vaccination programs.

Goal III: Prevention and Control

Enhance communication of public health information about emerging diseases and ensure prompt implementation of prevention strategies.

Objectives:

-- Use diverse communication methods for wider and more effective delivery of critical public health messages.
-- Establish the mechanisms and partnerships needed to ensure the rapid and effective development and implementation of prevention measures.

Goal IV: Infrastructure

Strengthen local, state, and federal public health infrastructures to support surveillance and implement prevention and control programs.

Objectives:

-- Ensure the ready availability of the professional expertise and support personnel needed to better understand, monitor, and control emerging infections.
-- Make available state-of-the-art physical resources (e.g., laboratory space, training facilities, and equipment) needed to safely and effectively support the preceding goals and objectives.

Return to top.

Table_2

To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

TABLE 2. Potential projects for Emerging Infections Epidemiology and Prevention Centers, United States

	Center Projects					
Potential center locations	Unexplained deaths of possible infectious etiology in young adults	Foodborne disease surveillance and prevention	Prevention of opportunistic infections in HIV- * infected inner-city populations	Drug resistance in nursing homes and day care facilities	Febrile and diarrheal illness in migrant farm workers	Etiologic agents of community-acquired pneumonia
Northeast	X	X	X			
Mid-Atlantic	X	X	X	X		X
Southeast	X	X	X		X	
South	X	X	X		X	X
Midwest	X	X		X	X	
Southwest	X	X		X		X
West	X	X	X	X	X	
Northwest	X	X		X	X	X
U.S. Pacific Islands	X	X				X
U.S. Caribbean Islands	X	X	X			

* Human immunodeficiency virus.

Return to top.

Table_B3

To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

BOX 3. Examples of potential members of a global consortium of epidemiology/biomedical research programs/centers

Existing networks

-- CDC Field Epidemiology Training Programs
-- International Clinical Epidemiology Network
-- International Office of Epizootics Worldwide Information System
-- Pan American Health Organization-CDC Dengue Surveillance Laboratory

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    Network
--  Pan American Health Organization Polio Eradication Laboratory
    Surveillance Network
--  World Health Organization Arbovirus and Hemorrhagic Fever
    Collaborating Centers
--  World Health Organization Global Influenza Surveillance Network

Existing research facilities

--  Caribbean Epidemiology Centre, Trinidad
--  CDC: National Center for Infectious Diseases Field Stations (Cote
    d'Ivoire, Guatemala, Puerto Rico, Kenya, Sierra Leone, and Thailand)
--  Department of Defense: U.S. Army Research Facilities (Brazil, Kenya,
    Thailand) and U.S. Naval Research Facilities (Egypt, Indonesia, Peru,
    Philippines)
--  Food and Agriculture Organization Reference Centers (Argentina,
    Brazil, Colombia, Czech Republic, France, Germany, Hungary, Kenya,
    Panama, Senegal, Spain, Sri Lanka, Thailand, United Kingdom, Uruguay,
    and the United States)
--  French Scientific Research Institute (e.g., Senegal, Congo, Cote
    d'Ivoire)
--  Instituto de Nutricion para Centroamerica y Panama, Guatemala
--  International Center for Diarrhoeal Disease Research, Bangladesh
--  National Institutes of Health, National Institute of Allergy and
    Infectious Diseases-supported facilities (Brazil, Colombia, Israel,
    Mali, Mexico, Philippines, Sudan, Uganda, Venezuela, and Zimbabwe)
--  Pasteur Institutes (e.g., Algeria, Central African Republic, French
    Guiana, Iran, Madagascar, Morocco, New Caledonia, Senegal, and
    Vietnam)
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Return to top.

Table_B4

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

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BOX 4. Implementation: high priorities for 1994-1996

Goal I: Surveillance

--  Strengthen notifiable disease surveillance at state and local levels.
--  Establish two physician-based Sentinel Surveillance Networks to detect
    and monitor emerging diseases, such as unexplained adult respiratory
    distress syndrome, drug-resistant pneumococcal disease, and childhood
    illnesses characterized by fever and rash.
--  Establish four population-based Emerging Infections Epidemiology and
    Prevention Centers to conduct focused epidemiology/prevention projects
    emphasizing foodborne and waterborne infectious diseases and
    potentially vaccine-preventable diseases.
--  Strengthen and link four existing research facilities/networks for a
    global consortium to promote the detection, monitoring, and
    investigation of infections emerging internationally that could affect
    the health of U.S. residents.

Goal II: Applied Research

--  Reestablish an extramural program to support emerging infectious
    disease prevention and control activities, such as evaluating the role
    of prescribing practices in the development of antimicrobial
    drug-resistant pathogens.
--  Initiate prevention effectiveness studies to assess the impact of food
    preparation guidelines on the incidence of foodborne infections such
    as E. coli O157:H7 and Salmonella enteritidis.

Goal III: Prevention and Control

--  Develop additional means to deliver laboratory and public health
    information informing health professionals about emerging infections
    and antimicrobial drug resistance.
--  Develop and implement guidelines for the prevention of opportunistic
    infections in immunosuppressed persons.

Goal IV: Infrastructure

--  Provide state-of-the-art training in diagnostic evaluation and testing
    for medical laboratory personnel to ensure the diagnosis and surveil-
    lance of emerging infections.
--  Establish a public health laboratory fellowship in infectious diseases
    that will train medical microbiologists in public health approaches to
    diagnosis and molecular epidemiology.
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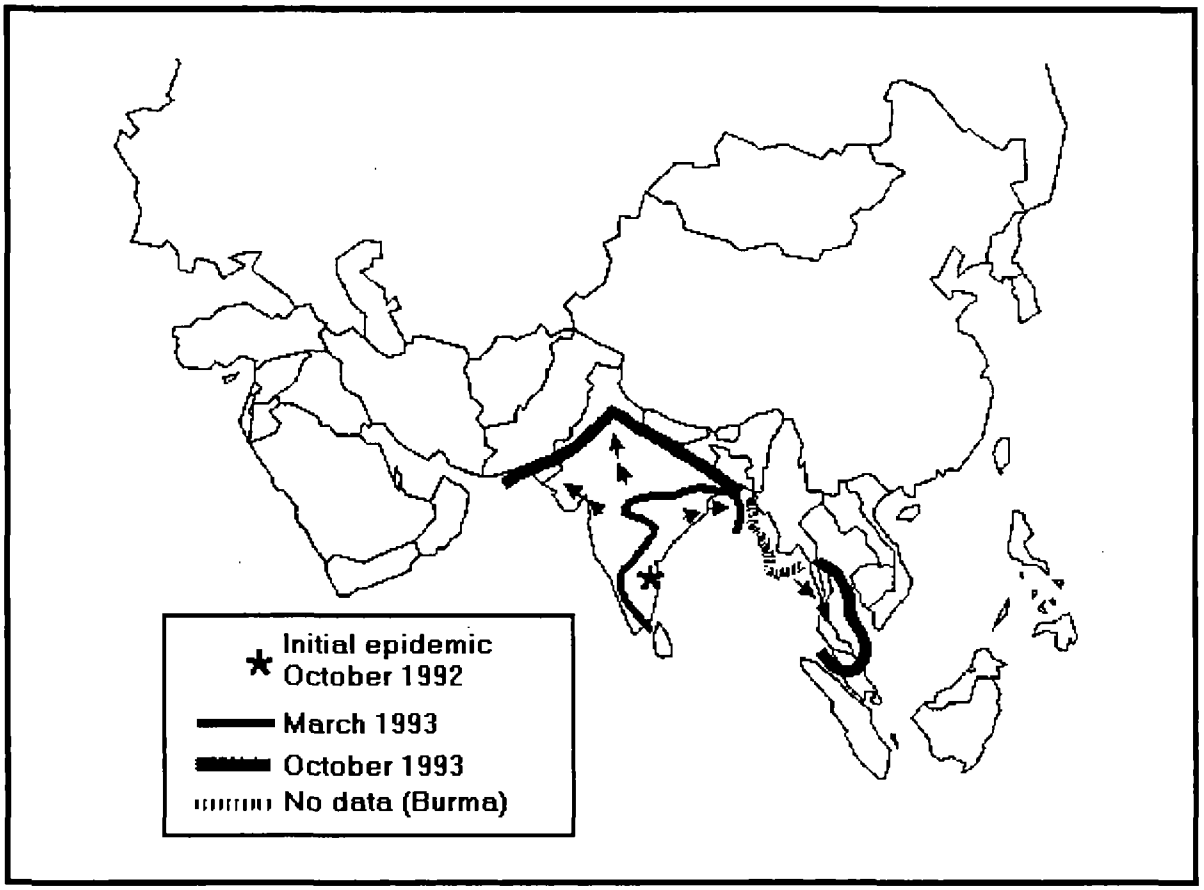
Return to top.

Figure_5

FIGURE 5. Migratory path of *Vibrio cholerae* O139 (Bengal) – Asia, 1992-1993



Return to top.

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April 15, 1994 / 43(RR-5);1-18

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

Ingenuity, knowledge, and organization alter but cannot cancel humanity's vulnerability to invasion by parasitic forms of life. Infectious disease which antedated the emergence of humankind will last as long as humanity itself, and will surely remain, as it has been hitherto, one of the fundamental parameters and determinants of human history.

- William H. McNeill in Plagues and Peoples, 1976

Summary

The spectrum of infectious disease is changing rapidly in conjunction with dramatic societal and environmental changes. World- wide, explosive population growth with expanding poverty and urban migration is occurring; international travel and commerce are increasing; and technology is rapidly changing -- all of which affect the risk of exposure to infectious agents.

Recent examples of important emerging infectious diseases include prolonged diarrheal illness due to waterborne Cryptosporidium, hemorrhagic colitis and renal failure from foodborne Escherichia coli O157:H7, pneumonia and middle-ear infections caused by drug-resistant pneumococci, and rodentborne hantavirus pulmonary syndrome. These diseases as well as resurgent diseases (e.g., tuberculosis and cholera) illustrate human vulnerability to microorganisms in the environment. Three recent reports by the Institute of Medicine document the need to address emerging infectious disease threats.

In partnership with representatives from health departments, other federal agencies, medical and public health professional associ- ations, and international organizations, CDC has developed a strategic plan to address emerging infectious disease threats. The plan contains four goals that emphasize surveillance, applied research, prevention and control, and public health infrastructure. To ensure sustain- ability, plan implementation will be approached in stages, as a long- term endeavor with emphasis on extramural programs. As health-care reform proceeds, priority should be given to strengthening partner- ships between health-care providers, microbiologists, and public health professionals to detect and control emerging infectious diseases.

INTRODUCTION

Once expected to be eliminated as a public health problem, infectious diseases remain the leading cause of death and disability- adjusted life years (DALYs) worldwide (1) and are among the leading causes of death in the United States (2). Dramatic changes in society, technology, and the environment, together with the diminished effectiveness of certain approaches to disease control, usher in an era wherein the spectrum of infectious diseases is expanding, and many infectious diseases once thought to be controlled are increasing (Box 1 Table_B1).

The term "emerging infectious diseases" refers to diseases of infectious origin whose incidence in humans has either increased within the past two decades or threatens to increase in the near future (3). To effectively address emerging infectious diseases, CDC has developed a strategic plan emphasizing

surveillance, research, and prevention activities necessary to maintain a strong defense against infectious diseases that affect, or threaten to affect, the public's health.

The goals of this plan address priorities for surveillance, applied research, prevention and control, and public health infra- structure, respectively:

Goal I. Detect, promptly investigate, and monitor emerging patho-

gens, the diseases they cause, and the factors influencing their emergence. Goal II. Integrate laboratory science and epidemiology to optimize

public health practice. Goal III. Enhance communication of public health information about

emerging diseases and ensure prompt implementation of prevention strategies. Goal IV. Strengthen local, state, and federal public health infra-

structures to support surveillance and implement prevention and control programs.

BACKGROUND

The Concept of Emergence

Many factors or combinations of factors can contribute to disease emergence. Newly emergent infectious diseases may result from changes in or evolution of existing organisms; known diseases may spread to new geographic areas or human populations; or previously unrecognized infections may appear in persons living or working in areas undergoing ecologic changes (e.g., deforestation or reforestation) that increase human exposure to insects, animals, or environmental sources that may harbor new or unusual infectious agents (Table 1) (4-7).

Infectious diseases may reemerge because of either the develop- ment of antimicrobial resistance in existing agents (e.g., gonorrhea, malaria, pneumococci) or breakdowns in public health measures for previously controlled infections (e.g., cholera, tuberculosis, and pertussis) (3).

The Burden of Infectious Diseases

In the United States and elsewhere, infectious diseases increas- ingly threaten public health and contribute substantially to the esca- lating costs of health care. For example, childhood ear infections are the leading cause of patient visits to pediatricians, and the incidence of visits for these infections increased 150% during 1975- 1990 (8). In addition, infectious agents may be causing diseases previously considered noninfectious: Helicobacter pylori has a well- established association with peptic ulcer disease and gastritis (9); sexually transmitted human papillomavirus is associated with cervical cancer (10); and infection with hepatitis C virus -- now recognized as a leading cause of chronic liver disease and cirrhosis in the United States -- occurs in an estimated 150,000 persons annually (11). Chlamydia infections have long been implicated in infertility and, more recently, have been tentatively associated with coronary artery disease (12), and rodentborne hantaviruses may play a role in hyper- tensive renal disease (13).

Infectious diseases account for 25% of all visits to physicians each year, and antimicrobial agents are the second most frequently prescribed class of drugs in the United States. (14,15). Direct and indirect costs of infectious diseases (e.g., economic losses and days of disability) may exceed an estimated $120 billion. Such approxi- mations, however, most likely underestimate the burden of infectious diseases. For example, the International Classification of Diseases (ICD-9) distributes infectious diseases across several categories, obscuring their public health impact (e.g., the classification of endocarditis among cardiovascular diseases and the classification of meningitis and middle-ear infections among diseases of the nervous system and sense organs, respectively).

The Threat of Emerging Infections

As a consequence of changes in society, technology, and the environment, pathogens evolve or spread, and the spectrum of infectious diseases expands. Emerging infections, such as human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), illustrate that no nation can be complacent regarding human vulnerability to microorganisms in the environment. Since the early 1970s, the U.S. public health system has been challenged by other newly identified pathogens and syndromes, such as Legionnaires' disease, Lyme disease, toxic shock syndrome, hepatitis C virus, and, most recently, hantavirus pulmonary syndrome (16-23). Moreover, the incidence of many diseases widely presumed to be under control -- such as cholera (24), dengue (25), yellow fever (26), and tuberculosis (TB) (27,28) -- has increased in many areas or spread to new regions or populations throughout the world. Because of widespread use and misuse of antimicrobial drugs, their effectiveness in treating common bacterial infections is diminishing, resulting in prolonged illnesses, higher mortality rates, and higher health-care costs (Figure 1) (29-35).

Emerging infections are particularly serious in persons with lowered immunity, such as those infected with HIV and those receiving immunosuppressive therapy for cancer or organ transplantation -- populations whose numbers are increasing (Figure 2). Other groups that may be disproportionately affected by emerging infections include the elderly; persons being cared for in institutional settings, such as hospitals and nursing homes; and persons with inadequate access to health care, such as the homeless, migrant farm workers, and others of low socioeconomic status.

The number of children attending day care facilities has increased in the past decade as more mothers of young children have entered the work force. These children, now numbering more than 11 million, are at a substantially increased risk for enteric infections, such as hepatitis A, giardiasis, and cryptosporidiosis; acute respir- atory illnesses; and middle-ear infections. Also, children who become infected can infect other members of a household (36).

Emerging infections transmitted by contaminated public water supplies place entire communities at risk. In the spring of 1993, contamination of a municipal water supply with the intestinal parasite Cryptosporidium caused the largest recognized outbreak of waterborne illness in the history of the United States; an estimated 403,000 persons in Milwaukee, Wisconsin, had prolonged diarrhea, and approxi- mately 4,400 persons required hospitalization (personal communication, Jeffrey P. Davis, communicable disease epidemiologist, Wisconsin). Large segments of populations may also be exposed to emerging infections through contaminated food products. For example, in 1993, hamburgers contaminated with the bacterial pathogen Escherichia coli O157:H7 and served at a fast-food restaurant chain caused a multistate outbreak of hemorrhagic colitis (bloody diarrhea) and serious kidney disease, resulting in the deaths of at least four children (37,38).

Limitations in both surveillance and the availability of appro- priate diagnostic tests constrain public health efforts to prevent and control outbreaks. Both E. coli O157:H7 and Cryptosporidium were first recognized as important human pathogens in the early 1980s, but neither has received adequate public health attention (Figure 3).

Exposure to certain animals also poses a risk for emerging infectious diseases. Hantavirus pulmonary syndrome, first recognized in the southwestern United States in 1993, has been linked to exposure to infected rodents in more than a dozen states. More than 60 cases have been detected; of those, more than half have died (Figure 4) (20-23).

Once considered "exotic," tropical infectious diseases are having an increasing effect on the U.S. public. Recent examples include severe illness and at least one death due to cholera among interna- tional airline passengers arriving in California (39); malaria among residents of southern California and immigrants in North Carolina (40,41); fever and heart failure in New York and Canada among patients who received blood transfusions contaminated with the bloodborne parasite (Trypanosoma cruzi) that causes Chagas' disease in Latin America (42,43); and a newly described form of leishmaniasis among troops returning from the Persian Gulf conflict (44,45).

From a historical perspective, cholera, smallpox, and plague are examples of infectious diseases that spread globally with devastating impact, often during periods of rapid economic change or population growth (7). Today, travel and commerce have fostered the worldwide spread of pathogens such as

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COMBATING THE SPREAD OF INFECTIOUS DISEASE

BACKGROUND

Increasing incidence of new infectious diseases. Once expected to be eliminated, infectious diseases remain as one of the leading causes of death in the United States. Between 1973 and 1995, more than thirty newly emerging infectious diseases were identified, including AIDS, toxic shock syndrome, Legionnaires disease, Lyme disease, and hantavirus pulmonary syndrome. The emergence of the Avian and Hong Kong influenzas last year and of hepatitis C this year has increased the disease burden and health care costs associated with emerging infectious diseases.

Drug resistance causes diseases that we thought conquered to reemerge. A number of familiar diseases, such as cholera, malaria, and tuberculosis, that were once under control have begun to increase and spread to new regions. The long term use and misuse of antibiotics have caused many microorganisms to adapt to these drugs, rendering them ineffective. In recent years, multidrug resistant tuberculosis and drug resistant pneumococcal infections (the most common cause of middle ear infections in children and pneumonia in the elderly) have become common. As a result, hospital stays are longer, health care costs are rising, and death rates are increasing.

Infectious diseases have enormous health consequences. Only 10 years after it was discovered, AIDS became the most common cause of death in young adults in the United States. Present estimates suggest that one out of every 65 Americans are infected with hepatitis C, a virus that causes chronic liver disease. This infection is already the leading cause of liver transplantation and in the next several years, the number of deaths from hepatitis C in the United States will surpass those from AIDS. In addition, 60 million unnecessary prescriptions are written every year for childhood viral infections that do not respond to antibiotics, making children's ear infections almost impossible to treat.

Infectious diseases contribute substantially to the escalating costs of health care. Approximately one out of every six domestic health care dollars are spent on infectious diseases, which account for 25 percent of all physician visits and constitute the most common reason for outpatient visits in the country. In addition, antimicrobial agents are the second most frequently prescribed class of drugs in the United States. Infectious complications in hospital settings result in an estimated $20 billion in excess health care costs. Direct and indirect costs of infectious diseases, including economic losses and days of disability, are estimated to exceed $120 million.

Emerging infections attack our most vulnerable populations. Emerging infections are particularly serious in people with lowered immunity, a population that includes those infected with HIV or receiving immunosuppressive therapy for cancer or organ transplantation. Children are also vulnerable to emerging infectious diseases; for instance, the 11 million children enrolled in day care programs are at a substantially increased risk of contracting an infectious disease, such as hepatitis A, acute respiratory illnesses, or middle ear infections.

Without additional resources, public health agencies will be unable to meet this new challenge. Because of technologic advances, evolving priorities, and categorical funding, State

and local health departments have built multiple, independent data collection systems to service specific program areas. These costly inefficiencies leave critical gaps and compromise the quality of information used for public health action. Communication between public health entities is also severely compromised. In a recent test, the CDC could not contact nearly half of local public health departments within 24 hours.

POLICY DESCRIPTION

Controlling emerging infections by implementing prevention strategies. Studies have shown that reductions in inappropriate antibiotic prescribing can lead to declines in antibiotic resistance. CDC together with other Federal agencies such as FDA and NIH, will work with private sector partners, including health plans, business coalitions, and professional organizations to launch a national media campaign to educate clinicians and the public about the consequences of inappropriate antibiotic use and the preferred course of treatment for hepatitis C.

Establishing a new integrated electronic disease surveillance network. A critical missing link in the nation's public health infrastructure is a national system that collects and analyzes epidemiological information on disease outbreaks. CDC will establish a new electronic disease surveillance network to facilitate the timely transmission of information from health care plans and providers to State and local epidemiologists and ensure that infectious disease cases that could signal the beginning of an outbreak are detected rapidly and that physicians are educated about the potential outbreak so that it is contained effectively.

Increasing and enhancing current surveillance activities. Like early warning systems that detect threats to national security, surveillance with appropriate laboratory support is a critical element in the defense against these diseases. CDC will increase the number of active surveillance sites, which currently require local and State laboratories to report the incidence of selected important diseases from eight to 10. All sites will expand their range of activities to conduct local investigations, education, and disease monitoring. CDC will also increase the number of sentinel provider networks, which work with key medical personnel at health departments, infectious disease clinics, and emergency rooms, from three to six. The enhancement to these systems will ensure that accurate and complete information is reported to State and Federal epidemiologists.

Enhancing the capacity of State and local health departments to respond to emerging disease threats. State and local health departments currently have multiple, independent data collection and communication systems that service limited program areas and constituencies and compromise the quality and the timeliness of data reporting. CDC will work with State and local health departments to integrate their current data and communication systems, reducing inefficiency and increasing the timeliness of information exchange. This system will ensure that critical disease outbreak information is used immediately for public health action. If physicians are informed about a common bacterial pattern of resistance, or which strain of influenza is circulating amongst their patients, it will result in patients receiving more appropriate care and allow health care professionals to plan ahead for next year's treatment needs.

PRESIDENT CLINTON UNVEILS THE SINGLE LARGEST INCREASE IN CDC FUNDS TO COMBAT THE SPREAD OF INFECTIOUS DISEASE

Today, President Clinton announced that his FY2000 budget would include $25 million for a new CDC initiative to control the spread of infectious diseases. This 31 percent increase over last year's funding level is the single largest increase in CDC funds dedicated to this cause. This new initiative will:

- **Control emerging infections by implementing prevention strategies.** Studies have shown that reductions in inappropriate antibiotic prescribing can lead to declines in antibiotic resistance. CDC, together with other Federal agencies and private sector partners, will launch a national media campaign to educate clinicians and the public about the consequences of inappropriate antibiotic use and the preferred course of treatment for hepatitis C. epidemiologists on site to develop resp
- **Implemnt new disease surveillance activities.** Like early warning systems that detect threats to national security, surveillance with appropriate laboratory support is a critical element in the defense against these diseases. CDC will establish a new electronic disease surveillance network to facilitate the timely transmission of information from health care plans and providers to State and local epidemiologists and ensure that infectious disease cases that could signal the beginning of an outbreak are detected rapidly and contained effectively. CDC will also substantially increase the number of active surveillance sites and sentinel provider networks. Surveillance sites will also begin to conduct local investigations, provider education, and disease monitoring activies.
- **Enhance the capacity of State and local health departments to respond to emerging disease threats.** State and local health departments currently have multiple data collection and communication systems that service limited program areas and constituencies, compromising the quality and the timeliness of information used to determine public health action. CDC will work with State and local health departments to integrate their current data and communication systems in order to reduce inefficiency and increase the timeliness of information exchanges.

information to plan what vaccines needed to plan for following year.

Today's announcement builds on the Clinton Administration's commitment to strengthen our nation's capacity to recognize and respond to the threat of infectious disease and other communicable pathogens.

Over the past three years, CDC has received $183 million over the past three years to address this pressing public health issue. In addition to expanding and enhancing current surveillance systems to monitor and thoroughly investigate unexplained deaths and severe illnesses, funds were used to develop molecular fingerprinting techniques to identify, track and prevent the spread of infectious pathogens.

NIH also received ___ in FY 1999 to make a significant investment in the development of new drugs to combat emerging and re-emerging diseases.

Preventing Emerging Infections

As recently as the 1960s, many scholars were proclaiming that infectious diseases had been vanquished, largely due to the availability of antibiotics and effective vaccines. However, the medical and public health communities severely underestimated the resilient nature of infectious agents. Microbes are uniquely adaptable life forms. They swiftly accommodate to, and even take advantage of changes in human behaviors, changes in the environment, changes in society, and our therapeutic control efforts. In recent years, we have witnessed the emergence of dozens of pathogens of public health significance.

These emerging infectious diseases (defined as those: [1] which have been newly recognized or have increased in incidence, or [2] those that have developed significant drug resistance) are among the most important health problems that we face today. Examples of newly recognized infectious diseases with major impact in the United States include HIV/AIDS, Lyme disease, *E. coli* O157:H7, *Helicobacter pylori*, and hepatitis C. Drug resistance in common community and hospital-acquired infections has become a therapeutic dilemma of epidemic proportions. Examples in the last few years include multidrug resistant tuberculosis, multidrug resistant food borne salmonella infections, and drug resistant pneumococcal infections (the most common bacterial cause of middle-ear infections in children and pneumonia in the elderly). Just in the past two years, strains of *Staphylococcus aureus* (the most common hospital acquired infection)

exhibiting partial resistance to vancomycin (the last line of defense against resistant strains) have been identified in the United States.

Emerging infectious diseases have enormous health consequences. Only ten years after it was discovered, AIDS became the most common cause of death in young adults in the United States. Present estimates suggest that one of every 65 Americans is infected with hepatitis C, a virus which produces chronic liver disease. This infection is already the leading cause of liver transplantation and in the next several years the number of deaths from hepatitis C in the United States will surpass those from HIV/AIDS. The economic consequences of these diseases are also substantial. Approximately one of every six U.S. health care dollars is spent on infectious diseases, which constitute the most common reason for out-patient visits in this country. Infectious complications in the hospital setting result in an estimated $20 billion in excess health care costs and over 80,000 deaths annually, and these figures are on the rise. Antibiotic resistant pneumococci cost hundreds of millions of dollars because of the need for more expensive therapeutic alternatives and excess hospital stays. It is estimated that the next influenza pandemic will produce almost 300,000 excess hospitalizations, almost 100,000 deaths, and as much as $170 billion in costs to the U.S. health care system. Experts tell us it is not a question of whether another influenza pandemic will occur, but when, as last year's episode of avian influenza in Hong Kong vividly illustrated.

Emerging infectious diseases impact the practice of medicine for every health care provider and the daily lives of every citizen in this country. Several examples serve as illustrations. Today:

- we cure peptic ulcers with antibiotics due to the discovery of the role of *Helicobacter pylori* in this disease in the 1980s
- we screen and treat pregnant women for group B *Streptococcus* to prevent fatal newborn infection, a strategy which has shown dramatic results with substantial cost savings
- in less than a decade we changed *Haemophilus influenzae* type b from the most common cause of meningitis in children to virtual elimination through childhood vaccination, and we are on our way to the same fate for severe infant diarrhea with the advent of the newly licensed rotavirus vaccine.

In spite of these successes:

- we know that almost 60 million unnecessary prescriptions are written every year for childhood viral infections that do not respond to antibiotics, and as a result children's ear infections are now almost impossible to treat
- we worry that the recognition of strains of *S. aureus* with reduced susceptibility to vancomycin herald an era where we cannot treat the millions of patients who experience common staphylococcal skin and wound infections every year
- we continue to watch the incidence of hemolytic uremic syndrome from *E. coli* O157:H7 food borne infections rise and we remain concerned about the safety of the foods we eat.

These are real time issues in critical need of a vigorous response. Since 1994, the Centers for Disease Control and Prevention (CDC) has been spearheading an effort with a variety of public

health, academic, and private partners to rebuild the critical national infrastructure needed to address the ongoing threat of emerging infectious diseases. CDC's strategy is based on four fundamental goals.

- Surveillance and response. Assuring that emerging infectious threats are promptly recognized and monitored, and that the health community is prepared to mount an appropriate response
- Applied research. Conducting critically needed research to identify risk factors for emerging health threats, develop diagnostic tests, identify cost effective prevention and control strategies, and evaluate these strategies
- Infrastructure and training. Assuring that there are well trained individuals and adequate facilities to conduct necessary surveillance and applied research, to implement prevention campaigns, and to harness the latest technology for the public health sector
- Prevention. Working with public health and clinical partners to implement prevention strategies which will reduce the magnitude of emerging infectious diseases in our communities.

Some examples serve to illustrate this approach.

- Monitoring for unexplained deaths and severe illnesses. Emerging diseases are often first recognized when they produce disease outbreaks - examples include hantavirus pulmonary syndrome in the southwestern United States, Legionnaires disease in

Philadelphia, and *E. coli* O157:H7 in Oregon and Michigan. However, each of these diseases was occurring at low frequency long before these outbreaks occurred, but went unrecognized. Using a network of 4 of the 8 Emerging Infections Program active surveillance sites, CDC is working with state partners and academic centers to monitor and thoroughly investigate unexplained deaths and severe illnesses which have eluded a diagnosis using state-of-the-art laboratory tests to determine their cause. This program should enable us to detect emerging diseases in these sites before they spread and produce widespread outbreaks.

- Application of molecular fingerprinting. CDC has pioneered and disseminated techniques to DNA fingerprint food borne pathogens such as *E. coli* O157:H7 and salmonella. Bacterial clones have unique fingerprints. Therefore, if strains with the same fingerprint are isolated from more than one patient, they can be presumed to have a common source. Routinely applying this technology in a network of state and federal public health laboratories known as PulseNet has led to the early recognition of a number of food borne outbreaks that would otherwise have been undiscovered. A national fingerprint database now resides at CDC so that partners can electronically submit fingerprint patterns and query the system for the presence of similar patterns. In 1997, the finding of 15 patients with identical strains of *E. coli* O157:H7 in Colorado led to the most massive recall of ground beef in U.S. history and the prevention of hundreds to thousands of cases of this serious illness. This technique was also recently used to identify a multistate outbreak of listeriosis that led to a national recall of contaminated

hot dogs and deli meats. PulseNet participants are currently able to fingerprint three important foodborne pathogens; the technology could potentially be applied to at least 20-25 important bacterial pathogens and related approaches could be applied to viral (e.g., hepatitis A) and parasitic (e.g., *Cyclospora*) pathogens. PulseNet currently consists of approximately 30 participating laboratories. The goal is to enroll 63 state, territorial, and large local jurisdictions in addition to CDC, FDA, and USDA laboratories.

- Judicious antibiotic use. Since we know that millions of unnecessary antibiotic prescriptions are written every year, CDC has launched campaigns to inform clinicians and the public of the consequences of inappropriate antibiotic use through brochures and other forms of media. In addition, community (in Wisconsin) and health care system-based (in Chicago) demonstration projects have been launched to implement strategies designed to reduce the prevalence of antibiotic resistance in these settings. We know from experiences in Finland and Iceland that reductions in antibiotic prescribing can lead to declines in antibiotic resistance. Recently there have been some encouraging data suggesting antibiotic prescribing has declined in certain health care settings, although probably not to the degree necessary to see an impact on regional or national resistance patterns.

Emerging infections can be controlled by implementing prevention strategies. As examples, the number of hospital outbreaks of multidrug resistant tuberculosis declined from nine during 1990-1993 to none during 1996-1998 through sound infection control measures; the incidence of food

borne listeriosis has declined by 44% since the late 1980s through combined industry and public health efforts; and the incidence of group B streptococcal disease has declined 60% since 1993 through implementation of CDC screening guidelines.

Major prevention opportunities exist. In particularly, exploring the role of infectious agents in chronic diseases (such as coronary heart disease); controlling the use of antibiotics; enhancing food safety; preparing for pandemic influenza; identifying and treating persons with hepatitis C; and development and evaluation of new vaccines can make substantial inroads into the burden of infectious diseases and reduce health care costs.

Over the next several years, CDC proposes to:

- increase the number of active surveillance sites (known as Emerging Infections Programs) from eight to 10 and expand the range of activities in existing sites
- enhance the capacity of state and large local health departments to monitor and respond to emerging disease threats (from 30 jurisdictions at present to all 63 eligible jurisdictions)
- expand the number of sentinel provider networks from three to six (current networks include infectious disease clinicians, academic emergency departments, and travel medicine specialists)
- perform applied research geared to developing better diagnostic and subtyping tools and identifying new vaccination strategies

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- develop professional and public educational programs using distance learning and internet technologies to transmit information and images
- expand training in emerging infections for laboratorians, clinicians, and health systems
- launch prevention campaigns related to antibiotic resistance and hepatitis C.

There has been substantial increase in recent investment in preparing the nation to address these issues:

	Emerging Infections Plan Implementation	Food Safety	TOTAL
1997	$44 million	---	$44 million
1998	$59 million	$10 million	$69 million
1999	$79 million	$15 million	$94 million
2000	$ _____	$ _____	$ ___ __

hepatitis C

Christa's cut

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Preventive Medicine

① Subsuming food safety under emerging infectious diseases.

② need to have an integrated electronic disease network