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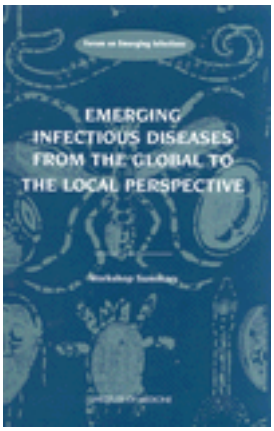

Emerging Infectious Diseases from the Global to the Local Perspective: Workshop Summary

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Summary and Assessment

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In October 1999, the Forum on Emerging Infections of the Institute of Medicine convened a 2-day workshop titled "International Aspects of Emerging Infections." Key representatives from the international community explored the forces that drive emerging infectious diseases to prominence. Representatives from the Americas, Africa, Asia and the Pacific, and Europe made formal presentations and engaged in panel discussions. Summaries of the formal presentations can be found in Chapter 1, Chapter 2, Chapter 3, Chapter 4 through Chapter 5 of this report. The topics addressed during this conference cover a wide range of issues, including trends in the incidence of infectious diseases around the world, descriptions of the wide variety of factors that contribute to the emergence and reemergence of these diseases, efforts to coordinate surveillance activities and responses within and across borders, and the resource, research, and international needs that remain to be addressed. This section of the report summarizes the issues raised during the 2-day meeting and suggests an agenda for future action.

EMERGING INFECTIONS: THE GLOBAL PICTURE

In his keynote address, David Heymann, Executive Director of Communicable Diseases for the World Health Organization (WHO), described the global proportions of infectious diseases. Infectious diseases are undergoing a global resurgence and threaten the health of everyone. They remain the world's greatest killer of children and young adults, accounting for more than 13 million deaths a

year and half of all deaths in developing countries, with six diseases causing 90 percent of deaths from infectious diseases: pneumonia, tuberculosis (TB), diarrheal diseases, malaria, measles, and human immunodeficiency virus infection (HIV)/AIDS (Figure 1).

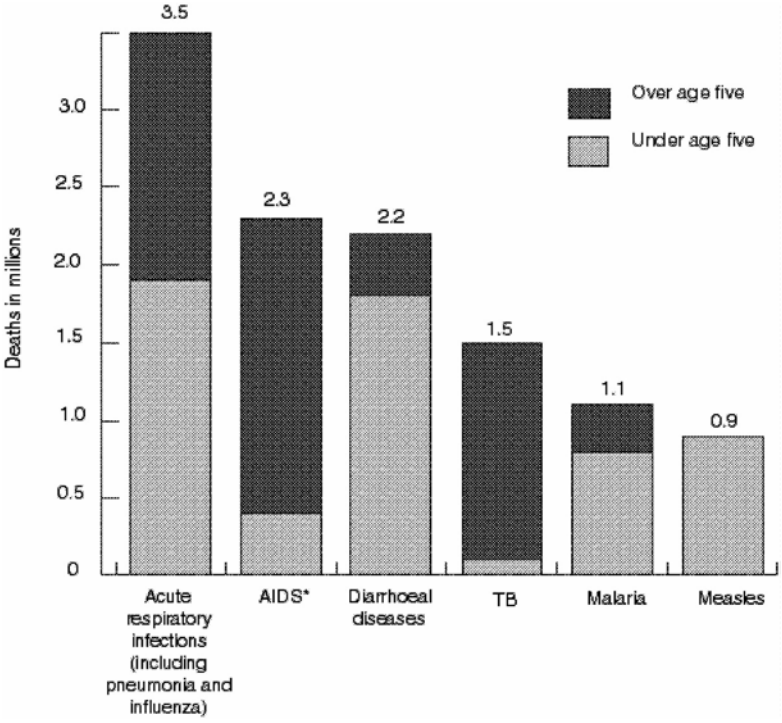

FIGURE 1 Leading infectious killers; millions of deaths worldwide, all ages, 1998. *HIV-positive people who died with TB have been included among AIDS deaths. SOURCE: WHO, 1999.

Even though most deaths from infectious diseases occur in developing countries, no region of the world is free from concern. In 1996 and 1997 alone, every continent experienced a large outbreak of some type of infectious disease, from Lyme disease in North America to Ross River virus in Australia (Figure 2). Therefore, it is in the best interest of all countries to support global initiatives to control infectious diseases.

In addition, the growing rise and spread of antimicrobial resistance is of increasing concern in developed countries as the inappropriate use of antibiotics goes unchecked. Moreover, increasing numbers of international travelers provide a vehicle for the rapid spread of microbes resistant to antimicrobial agents. For example, in 1995 two different clones of multidrug-resistant *Streptococcus pneumoniae* were first identified in Spain, and within 2 months the strains had

been found in Croatia, France, Mexico, Portugal, Korea, South Africa, and the United States (Figure 3).

The reemergence of infectious diseases once thought to be under control or eliminated is also a growing concern. For example, dengue fever is a disease of humans in tropical and subtropical regions caused by the dengue virus, which is transmitted from human to human by the bite of an infected *Aedes* mosquito. In the past decade, countries in the Americas, Southeast Asia, and Western Pacific have witnessed a resurgence of dengue fever and its most serious manifestation, dengue hemorrhagic fever (Figure 4). Yet, the rise of dengue is not the only concern of the global population public health community. In 1996, outbreaks of polio in Albania, Greece, and Yugoslavia, and more recently in Haiti and the Dominican Republic, demonstrated that when immunization practices and disease surveillance are neglected, diseases can easily be reintroduced into countries once free of a malady.

Financial Costs of Infectious Diseases

Beyond the human suffering, the financial costs of infectious diseases are great, especially for developing countries (Table 1). The economic burden of malaria alone has cost Africa billions of dollars over the past decade. When infectious diseases are not controlled, they take a tremendous toll on the econo port of goods. Although they are not always high on the list of causes of mortality, infectious diseases may be high on the list of causes of economic morbidity:

- In 1994, the panic over plague in India cost the country an estimated $1.8 billion in lost tourist income and trade.

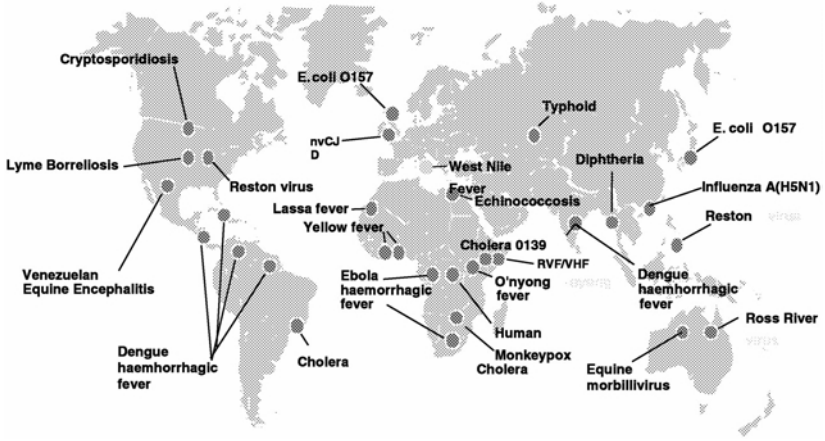

FIGURE 2 Emerging/reemerging infectious diseases, 1996 and 1997.
SOURCE: WHO/ CDS, 1999.

TABLE 1 Infectious Diseases and Their Costs to Economies

Year(s)	Country	Disease	Cost (millions of US$)
1990 to 1998	United Kingdom	Bovine Spongiform Encephalopathy	>5,740
1991	Peru	Cholera	770
1991	India	Plague	1,800
1994	India	Tuberculosis	>1,000
1997	Tanzania	Cholera	36
1997 to 1998	Thailand	HIV/AIDS	2,500

SOURCE: Workshop presentation by David Heymann, World Health Organization, 1999.

- In 1996 the European Union banned the worldwide export of British beef in response to fears about bovine spongiform encephalopathy (so-called mad cow disease).
- In 1998 the European Union erected trade barriers because of a cholera outbreak in East Africa, where the disease is endemic.

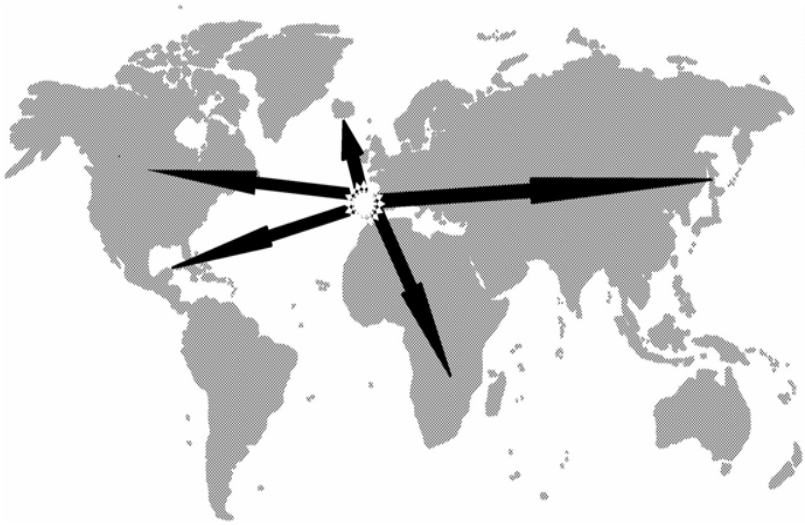

FIGURE 3 *Streptococcus pneumoniae:* probable spread of two multi-resistant clones in a two-month period. First clone in Spain, subsequently in Croatia, France, Mexico, Portugal, Republic of Korea, South Africa, and the United States. Different clone, first seen in Spain, and subsequently in Iceland. SOURCE: WHO Report WHO/CDS/ BVI/95.7.

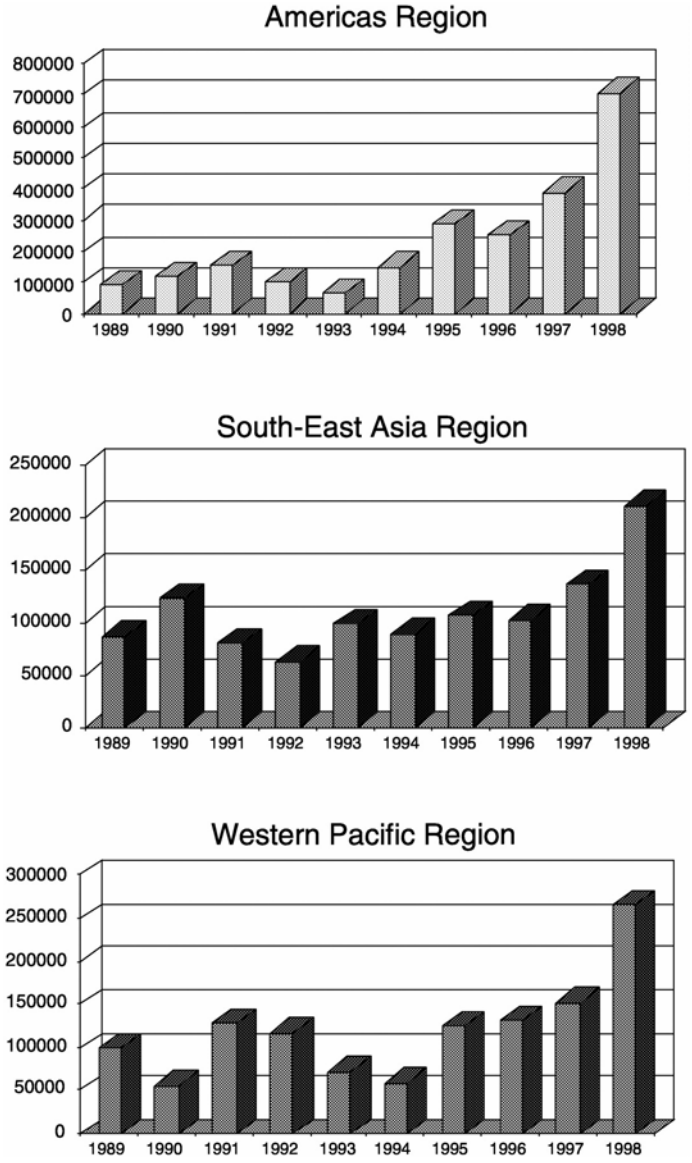

Figure 4 Resurgence of dengue fever and dengue hemorrhagic fever; number of cases. SOURCE: WHO/CDS, 1999.

Additionally, the economic and societal costs of controlling infectious diseases are directly proportional to the response time to control the disease. For example, the emergence of HIV/AIDS has prompted a global resurgence of tuberculosis (TB), especially multidrug-resistant TB (MDR-TB). Treatment costs for TB can vary between $15 and $40 per person to achieve a complete cure, whereas treatment costs for MDR-TB are $3,000 per person. Considering that total spending for health care in some of the poorest countries in the world is less than $7 per person per year, the increased costs associated with a delayed response to disease control are beyond the reach of the poorest countries. Not only does treatment become impossible as economic and societal costs increase, but infectious disease control is often neglected, as are disease prevention efforts.

Infectious Diseases and Human Rights

In some countries the issues of the spread and control of infectious diseases are interwoven with concerns about human rights. In some Asian countries large populations migrate to neighboring countries. However, if an immigrant contracts HIV or even viral hepatitis, the person is frequently sent back to the country of origin, a place from which he or she might have fled. Thus, some are hesitant to seek medical care and often go "underground," spreading the disease even further. The Hong Kong Special Administration Region counters this possibility by ensuring that individuals who are positive for HIV are offered a full range of services, with the assurance that they will not be deported or detained if they seek medical care.

Infectious diseases among incarcerated individuals are also on the rise worldwide. In Russia, 42 percent of all TB cases are detected in the prison population. Every year the system incarcerates 300,000 otherwise healthy Russians and releases another 300,000, most of whom will have been exposed to TB during their incarcerations. Among these individuals, approximately 10 percent develop active disease and 80 percent carry the TB bacterium in a latent state. Approximately 40 percent of those patients are exposed to MDR strains. Among the amplifiers of drug resistance is the delay of implementation of directly observed treatment (short course) and poor health care services in Russian prisons. Tragically, the MDR-TB crisis is almost at the point at which the disease may never be controlled there unless second line drugs are introduced into the prison system (see Chapter 5).

Thus, efforts to control the spread of infectious diseases often encounter national and regional issues to which the international community is sometimes hesitant or unable to respond. Better surveillance for diseases in refugee and prison populations is needed to detect infectious agents, institute therapy or control strategies, and prevent or mitigate the impact and further spread of contagion.

FACTORS IN EMERGENCE OF INFECTIOUS DISEASES

Specific factors are responsible for the emergence of infectious diseases. With proper epidemiological investigations and laboratory surveillance, the determinants of disease outbreaks can be identified, as most emerging infections (even those resistant to antimicrobial agents) usually originate in one location and then disseminate to new areas. Complacency about vaccination and antibiotic use, however, and the lack of investment in surveillance and control programs have exacerbated the spread of many diseases. Climate variability and natural disasters also play a role in the emergence of many infectious diseases. For example, the traditional meningitis A belt was limited to Saharan Africa. Recently, however, there have been epidemics occurring farther south, in Uganda, Kenya, and Tanzania, and these are likely related to droughts in those areas. In some countries, devastating earthquakes and floods have contributed to outbreaks of cholera, malaria, TB, and diarrheal diseases.

In the past 20 years a number of global activities have resulted in an increase in the level of spread of infectious microbes and have promoted the emergence of diseases and epidemics (Table 2). Many of these factors lie outside the purview of the health sector, making it difficult to mitigate their impact on the transmission of infectious diseases and requiring coordinated approaches among various sectors of society for successful control. For example, economic and environmental policies can have direct and negative effects on the emergence and spread of infectious diseases. Deforestation and changes in land and water use can also affect disease patterns, triggering outbreaks of parasitic or other infectious diseases.

TABLE 2 Factors in Infectious Disease Emergence and Reemergence

Increased human intrusion into tropical forests
Lack of access to health care
Population growth and changes in demographics
Changes in human behaviors
Inadequate and deteriorating public health infrastructure
Misuse of antibiotics and other antimicrobial drugs
Microbial adaptation
Urbanization and crowding
Modern travel
Increased trade and expanded markets for imported foods

SOURCE: IOM, 1992.

Global Trade and Travel

Global trade has increased 1,000 percent since World War II. Sixty percent of global trade occurs in the Asia-Pacific region alone, resulting in an incredible movement of merchandise and people. Moreover, 20 percent of global agricultural trade occurs in Asia, which is the major destination market for U.S. trade goods, with the rate of agricultural product sales increasing 7 percent each year. As a large fraction of the economies of most developed nations are invested in trade, the level of exchange of goods will continue to increase.

One of the drawbacks to this movement of goods is that antimicrobial agents and other drug classes used to treat products may result in alterations in the ways in which people react to infections. Therefore, trade can introduce new pathogens or their vectors into a region through the shipping of contaminated products. In addition, increased world trade—combined with greater world travel—is precipitating some infectious disease events. Mitigation of these events requires greater investment in the public health infrastructure, disease investigation, sanitary infrastructure, strengthening of health ministries and other health agencies within governments, and coordinated action among the various sectors of society that deal with these issues.

Global travel also affects the transmission of infectious diseases. Nearly 1.5 billion travelers board airplanes every year, and the proportion of international arrivals among continents is increasing (Figure 5). The resulting effects include the importation of infectious diseases and infectious disease agents; for example, importation of influenza, pneumonic plague, TB, malaria, and even poliovirus by air travelers has been reported. In 1996, sporadic cases of yellow fever were diagnosed among travelers returning to the United States and Switzerland. Beyond tourism, as mentioned previously, migration also contributes to the spread of disease, which can be exacerbated when immigrants and refugees live in overcrowded and unsanitary conditions.

Seasonality and Climate Variation

The rise and fall in the rates of infectious diseases, particularly influenza, have long been associated with changes of seasons. In the tropical areas of the world there is a greater occurrence of influenza during the rainy season, and some believe that closer human contact during the rainy season in the tropics, when people tend to congregate indoors, might be responsible for more cases of influenza. This is in contrast to the epidemic situation in temperate regions, where there is a winter seasonality for influenza. In the winter, cooler, drier air favors the survival of influenza viruses, and just as in the tropics during the rainy season, people tend to congregate inside.

Other diseases show seasonal trends as well. Outbreaks of Venezuelan equine encephalitis in Colombia are associated with the rainy season. Respiratory syncytial virus (RSV) causes disease in the Northern Hemisphere in the

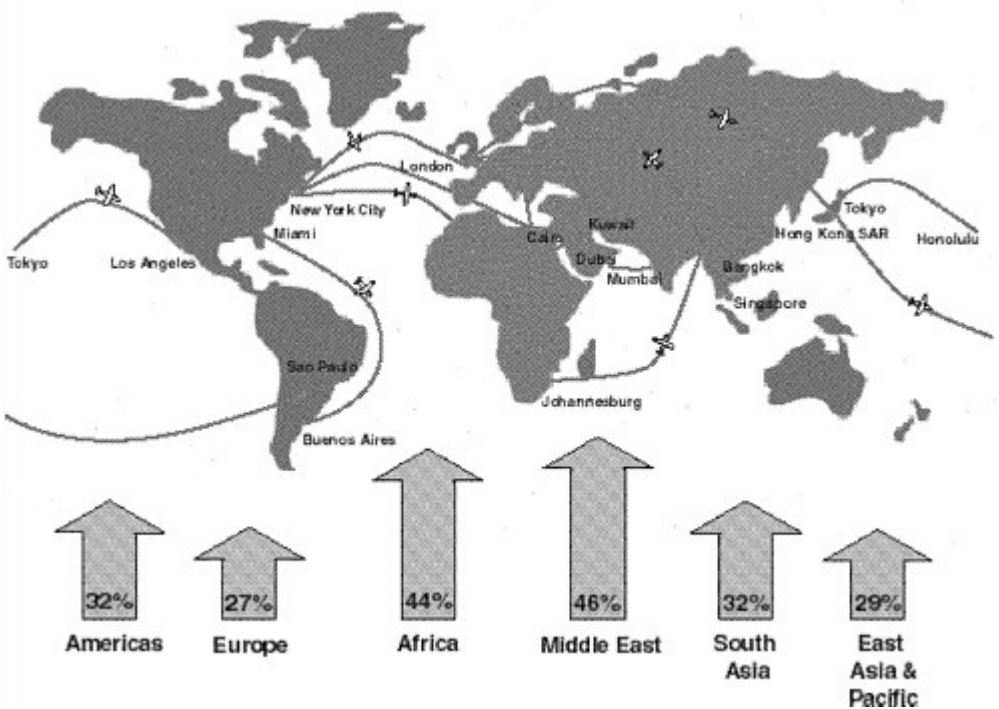

FIGURE 5 Frequent flyers: the most popular routes between continents, 1997. Percentage increase in international arrivals, 1993–1997. SOURCE: World Tourism Organization and Civil Aviation Organization.

winter and in the tropics during the rainy season. In England, for example, RSV is as important as influenza virus in causing morbidity and excess mortality among elderly people (Fleming and Cross, 1993).

The use of climate information for public health purposes deserves additional attention. Incorporation of climate and environmental variables into predictors of disease outbreaks could be an important tool for infectious disease prevention and control. For example, climate data have been used in retrospective analyses and modeling of Rift Valley fever outbreaks in East Africa. Refinement of such models could contribute to the planning for animal immunization programs. Knowledge and understanding of seasonal climate and meteorological conditions in West Africa have also been important for the elimination of onchocerciasis from that region. Historically, modeling has been used to predict malaria transmission on the basis of climate data, but the challenge to using these models is obtaining and validating quality data on the ground.

Zoonoses

In both developing and developed countries a number of new zoonoses (diseases transmitted from animals to humans) have emerged. These have been caused by either newly discovered pathogens or agents that are already known, often appearing in animal species in which the disease had not previously been detected. Zoonotic disease agents have also reemerged in some areas after being absent for many years, sometimes decades. Examples of emerging and reemerging zoonotic disease agents include equine morbillivirus, Japanese encephalitis virus, and Australian bat lyssavirus in Australia, equine encephalitis virus in Colombia and Venezuela, enterohemorrhagic *Escherichia coli* in Japan, the bovine spongiform encephalopathy agent in the United Kingdom, and dengue virus in South America.

A dramatic example of a recent zoonotic disease outbreak was the occurrence of H5N1 influenza A virus—the so-called avian or bird flu—in Hong Kong in 1997 (Figure 6), which resulted in the slaughter of millions of chickens. Hong Kong is particularly vulnerable to infectious diseases because it is densely populated (6.68 million population in 1998), is in the crossroads between the East and the West, encounters a heavy volume of international travel, and has live poultry markets in close proximity to residential areas, which facilitate the spread of the virus from infected chickens to humans (see Chapters 4). Intense media attention to the outbreak highlighted the power of telecommunications to transmit images and mobilize and accelerate the response to an outbreak.

The juxtaposition of human and animal populations increases the likelihood of such outbreaks. Another example is Argentine hemorrhagic fever (AHF), which has been a major public health concern since 1955. The Argentine government is effectively using the AHF vaccine to reduce the incidence of disease. The incidence of AHF, however, has gradually increased among adult agricul

tural workers in rural areas, indicating an occupational exposure to the virus, and the focal incidence of AHF correlates well with the distribution of rodent infestation. The affected area in Argentina has gradually been extending and now covers approximately 150,000 square kilometers (58,000 square miles) including densely populated areas in parts of Argentina where the population at risk is approximately 5 million (see Chapter 2).

Of the novel zoonotic diseases, Hendra virus was first recognized as an outbreak of an unknown illness among horses in Brisbane, Australia. The virus was shown to occur naturally in fruit bats and to be widely distributed in northern and eastern Australia, as well as in Papua New Guinea. Hendra virus has been classified as the first member of a new genus in the family *Paramyxoviridae.* Studies of Hendra virus led to the discovery of Australian bat lyssavirus, a rabies-like virus, in both fruit and insectivorous bats. Australian bat lyssavirus is in the same group to which classical rabies belongs, antigenic group 1 of the lyssaviruses, but Australian bat lyssavirus can be differentiated from rabies virus on genetic grounds (see Chapter 4).

The emergence of zoonoses is likely to persist owing to increased human-to animal interactions, increased production and manufacture of animal-derived food products, changes in food-processing practices, and encroachment of human populations into feral animal habitats, as well as increased global trade and

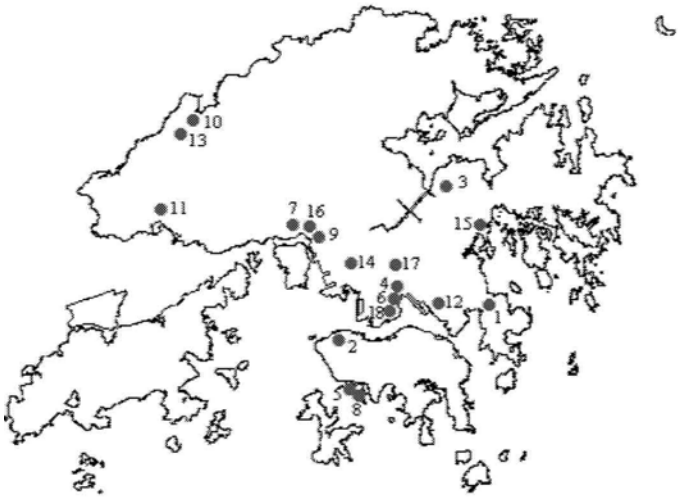

FIGURE 6 Geographic distribution of H5N1 cases in Hong Kong.

transportation of animals and animal products. Zoonotic outbreaks emphasize the importance of a robust public health infrastructure for disease surveillance and the need for international efforts and multidisciplinary collaboration to address such public health threats. Apart from human and animal health and welfare, due consideration must be given to the economic and political effects of zoonotic disease outbreaks.

Food Safety

Ensuring a safe food supply can have a large impact on the reduction of many common infectious diseases, such as diarrheal diseases, many of which originate in food products from animals. To reduce this impact, better, more reliable disease surveillance data are needed to effectively identify the cases of disease and to document the occurrence of specific pathogens and the sources of the infection. Much of the focus on food-borne disease control, however, is on other approaches, such as vaccines for animals raised for human consumption, and most of the public health community is not fully aware of the value of ensuring a safe food supply as a control mechanism.

Antimicrobial Drug Use in Animals and Humans

The use of antimicrobial agents in animal husbandry and agriculture is a mounting concern. In fact, about 50 percent of the antimicrobial agents produced are used in animal husbandry, agriculture, and horticulture. According to the U.S Department of Agriculture, during 1996 more than 136,000 kilograms (300,000 pounds) of streptomycin and oxytetracycline were sprayed on U.S. apples and pears to prevent or treat fire blight. In South Asia, rice fields and orchids are also sprayed with antibiotics to prevent blights and infections. These antimicrobial agents can enter the environment and then can enter humans through human ingestion of products contaminated with antimicrobicide residues.

The growth promoters and prophylactic antibiotics used in animal feed to promote health are subject to little regulation, however. In particular, fluoroquinolones are a valuable new class of drugs for use in humans. They are increasingly being used to promote health in poultry, from which the drug is excreted unchanged and remains biologically active after it is excreted, raising the potential for contamination of the environment and ingestion by other animals raised for human consumption. In fact, a publication from the state of Minnesota reported *Campylobacter* isolates from humans and as well as chicken in grocery stores that contained fluoroquinolone-resistant *Campylobacter.* Concerns about unrestrained practices are leading some Asian governments to control the animal feed being used on farms and to legislate the use of antibiotics and other drugs. In general, more efforts should be made to monitor isolates from food or food-source animals.

Equally troubling is the increase in the spread of drug-resistant microbes in humans (Table 3). Through the inappropriate use of antibiotics and normal microbial evolution, a growing number of infectious microorganisms are becoming drug resistant. For example, a resistant strain of the TB bacterium, *Mycobacterium tuberculosis,* recently appeared in the United States. Penicillin resistance has also been seen in strains of the microorganisms that cause pneumonia, meningitis, and middle-ear infections. In Argentina the rate of penicillin resistance among respiratory system pathogens, such as *Streptococcus pneumoniae* (24 percent) or *Haemophilus influenzae* (15 percent), is, on average, similar to that observed in Europe and the rest of the Americas; however, an alarming proportion of enteropathogenic isolates, like *Salmonella* and *Shigella* are resistant to first-line drugs. This phenomenon has not been observed in other regions. Hospitals worldwide are facing unprecedented crises from the rapid emergence of antibiotic-resistant microorganisms. Infectious diseases such as cholera, malaria, and tuberculosis—once thought to be nearly eradicated, particularly in developed countries—are making a comeback (Figure 7). In addition, the agents responsible for endemic and new diseases, including pneumonia and HIV/AIDS, are starting to develop drug resistance as well.

Drug-resistant forms of these diseases can become untreatable in any country. The impact of this trend could be reduced through better prescription practices, better training for health workers, better public education, and greater control over the availability of nonprescription drugs. National surveillance systems are needed to detect and respond to antimicrobial resistance in its early stages.

TABLE 3 Antibiotic-Resistant Disease-Causing Bacteria

Disease	Bacterium	Antibiotic Resistance
Dysentery	*Shigella dysenteriae*	Multidrug resistant
Gonorrhea	*Neisseria gonorrhoeae*	Penicillin and tetracycline resistant
Nosocomial infections:	*Enterococcus* species	Vancomycin resistant
	Klebsiella species	Multidrug resistant
	Pseudomonas species	Multidrug resistant
	Staphylococcus aureus	Methicillin resistant
Pneumonia	*Streptococcus pneumoniae*	Multidrug resistant
Typhoid	*Salmonella enterica*	Multidrug resistant

SOURCE: Workshop presentation by David Heymann, World Health Organization, 1999.

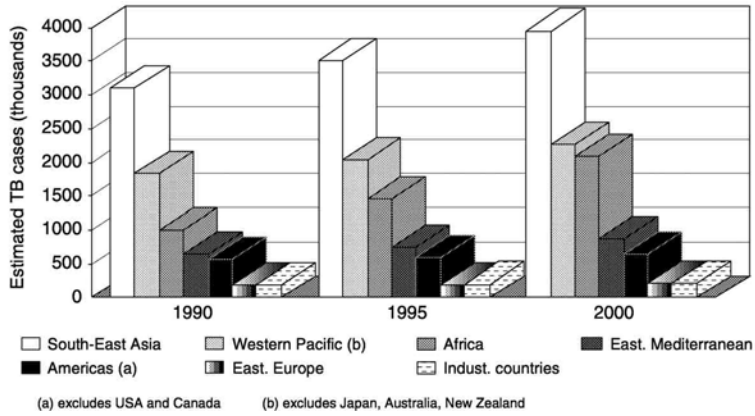

FIGURE 7 Tuberculosis in 1990, 1995, and 2000. There were 53,000 deaths/ week in 1995. SOURCE: WHO/CDS.

Slowed Vaccine and Drug Development and Degraded Immunization Policies

More than 20 new infectious agents or diseases have been identified in the past 20 years, including toxic shock syndrome, HIV/AIDS, hantavirus pulmonary syndrome, and Nipah virus, to name just a few (Table 4). Like the organisms themselves, the challenges of detecting and preventing infectious diseases are constantly evolving. A strong, stable research and training infrastructure is needed to investigate the mechanisms of molecular evolution, drug resistance, and disease transmission to produce the knowledge that can lead to a vaccine or other effective means of preventing and treating an infectious disease. Just as an expanded research effort led to the discovery of protease inhibitors as treatments for HIV/AIDS, a renewed commitment to research is needed to ensure that similar successes are achieved for the numerous other infectious diseases currently threatening the earth's human population. Although vaccines against acute respiratory infections, diarrheal diseases, HIV/AIDS, malaria, TB, and dengue are desperately needed, vaccine development has lagged in the past 20 years. Vaccines are in the pipeline for Chagas' disease, onchocerciasis and lymphatic filariasis, leishmaniasis, schistosomiasis, and malaria, but these are in the predevelopment stage and still far from ready for use (WHO, 1999).

The rate of new antibiotic development has also slowed (Table 5). Industry is not always willing to invest in the development of a new class of antibiotics as readily as it was 20 or 30 years ago because of the financial risks involved. For

TABLE 4 Newly Identified Infectious Diseases and Pathogens

Year	Disease or Pathogen
1999	Nipah virus
1997	H5N1 (avian influenza A virus)
1996	New variant Creutzfelt-Jacob disease Australian bat lyssavirus
1995	Human herpesvirus 8 (Kaposi's sarcoma virus)
1994	Sabia virus
	Hendra virus
1993	Hantavirus pulmonary syndrome (Sin Nombre virus)
1992	*Vibrio cholerae* O139
1991	Guanarito virus
1989	Hepatitis C
1988	Hepatitis E
	Human herpesvirus 6
1983	HIV
1982	*Escherichia coli* O157:H7
	Lyme borreliosis
	Human T-lymphotropic virus type 2
1980	Human T-lymphotropic virus

SOURCE: Workshop presentation by David Heymann, World Health Organization, 1999.

TABLE 5 Antibiotics Developed Since 1940

1940–1950	1951–1960	1961–1970	1971–1990	1991–1999
Bacitracin	Cycloserine	Gentamicin	Aztreonam	New versions of
Cephalosporin	Erythromycin	Lincomycin	Ciprofloxacin	Beta-lactams
Chloramphemicol	Fusidic acid	Nalidixic acid	Clindamycin	Quinolones
Framycetin	Kanamycin	Spectinomycin	Imipenem	Macrolides
Neomycin	Novobiocin	Tobramycin	Trimethoprim	
Penicillin	Rifampin			
Polymycin	Spiramycin			
Streptomycin	Vancomycin			
Sulfonamide				
Tetracycline				

SOURCE: Workshop presentation by David Heymann, World Health Organization, 1999.

example, the development of an antibiotic is an expensive process, and there is no guarantee that the antibiotic will remain effective before the patent period is over and the investment has been regained.

Globally, the number of individuals covered by immunizations, in addition to immunizations against polio, has risen since the advent of the global polio eradication initiative in 1990. However, standard immunizations for children are not as widespread as expected in many less developed regions of the world, where the risk of infectious diseases remains high. High vaccine costs, difficulties with administration (e.g., the logistics of refrigerating vaccines in tropical climates), and the number of vaccinations that each individual needs pose challenges to the implementation of more widespread immunization requirements, as well as posing challenges to immunization practices. In addition, when immunization programs are working well, they are sometimes forgotten. As a result, countries that have relaxed their immunization requirements are facing endemics and, in some cases, epidemics. For example, in Russia the pertussis vaccine component was dropped from the standard diphtheria-pertussis-tetanus vaccine preparation, resulting in an emergence of pertussis.

Another example is the risk of reemergence of poliomyelitis because of decreasing levels of vaccine coverage and indicators suggesting the breakdown of intensified surveillance, as currently seen in Haiti and the Dominican Republic. Although the last confirmed case of poliomyelitis on the North American continent was reported in June 1991, importation and spread of wild-type poliovirus strains into North America has been documented on two occasions in Canada (1992 and 1996), since then. The outbreaks occurred in members of religious communities that objected to and refused vaccination. This type of episode is especially problematic because of breakdowns in active surveillance.

Measles presents another example of how a disease that was nearly eradicated can be reestablished. Measles was on the verge of being controlled in Latin America in 1996, until the occurrence of outbreaks in Brazil, Argentina, and Bolivia. Now, Colombia and other countries in Latin America are in the final phases of the elimination of measles.

The need for basic immunization programs is often overshadowed by threats posed by new infectious agents with more dramatic clinical consequences. Although diseases like Ebola hemorrhagic fever receive much attention, diseases like measles do not. For example, in the Democratic Republic of Congo (formerly Zaire) in 1995, 350 people died from Ebola hemorrhagic fever in 1 year, whereas 350 children died from measles every 2 days. The challenge, in the words of a former director of the Centers for Disease Control and Prevention (CDC), William Foege, is to “link the fears of the rich with the needs of the poor.” More intensive monitoring of immunization policies is needed to ensure that critical vaccinations are provided to the population. Those responsible for dissemination have to be reminded about the requirements of various vaccines, for example, that diphtheria-pertussis-tetanus vaccines should not be frozen.

NEED FOR COORDINATION AND COLLABORATION

Several governments have launched national efforts toward combating infectious diseases. In 1996 the United States announced new domestic and international surveillance and prevention efforts, including an initiative that seeks to improve research that will lead to new tools to detect and control emerging infectious diseases, as well as more basic research on the biology and pathology of infectious agents. The National Science and Technology Council's Committee on International Science, Engineering, and Technology Task Force on Emerging Infectious Diseases coordinated the overall initiative; the CDC and the U.S. Department of Defense (DOD) the surveillance and response efforts, and research activities were led by the National Institutes of Health. Threat reduction funds managed by both the U.S. Department of Defense and the U.S. Department of State are used to engage the former biological warfare facilities in the former Soviet Union in public health activities. The National Academy of Sciences has engaged in discussions with scientists at these facilities in collaborative pilot projects. For example, there is an attempt to reinvent the Stepnogorsk biological research facility in Kazakhstan, which previously weaponized the agent responsible for anthrax, to serve as a national TB reference center.

Other countries are developing and refining similar national plans. In Argentina, the objectives of a strategic plan to address emerging and reemerging infectious diseases include research and analysis of the results obtained by the country's diagnostic laboratories and application of the results of these analyses to surveillance and the development of policies related to infectious diseases. Since 1960, the Argentine National Epidemiological Surveillance System has collected information on 60 infectious diseases for which weekly notification by provincial public hospitals is mandatory. In addition, since 1992—after a cholera outbreak—the public health laboratory network for cholera has confirmed the results obtained through the mandatory notification process (see Chapter 2).

Mexico has instituted special surveillance programs in response to natural disasters. After such events, for example Hurricane Mitch, new infectious disease events are exacerbated by the migration of individuals from Central America into Mexico, as well as the hygienic problems caused by the heavy rainfall and flooding. A program in five Mexican states performs the laboratory diagnosis of dengue, leptospirosis, enterobacterial infection, and cholera. The program also provides reagents to laboratories and performs quality control testing and training (see Chapter 2) (Figure 8).

The United Kingdom has developed a pandemic influenza contingency plan. It defines the roles and responsibilities of all the organizations and people who would be involved in the response to a new pandemic. The plan moves in phases from the interpandemic period, to an outbreak outside the United Kingdom, to outbreaks within the United Kingdom, to the pandemic stage and the

end of the pandemic. Currently, the effort is to bring the plan into concordance with that of WHO (see Chapter 5).

Other efforts have been explicitly transnational. For example, a project developed jointly by the African Regional Office of WHO, the CDC, and the U.S. Agency for International Development (USAID) aims to improve the well-being of the approximately 600 million people currently residing in the 47 member states of the African Regional Office of WHO. The project implements integrated infectious disease surveillance and improved epidemic preparedness and response (see Chapter 3).

Correspondingly, in June 1995 the Pan American Health Organization (PAHO) convened a meeting of international experts to discuss strategies for the prevention and control of emerging infectious diseases. As a result of that meeting, a regional plan of action was prepared to develop regional and subregional approaches and to guide member states in addressing specific problems (Figure 9). The regional plan has four goals: (1) strengthening regional surveillance networks for infectious diseases in the Americas; (2) establishing national and regional infrastructures for early warning about and rapid response to infectious disease threats through multidisciplinary training programs and enhancement of laboratory capabilities; (3) promoting the further development of applied research in the areas of diagnosis, epidemiology, prevention, and clinical studies; and (4) strengthening the regional capacity for effective implementation of prevention and control strategies (see Chapter 2).

The European Union (EU) has changed the environment for public health issues in Europe by providing funds and the opportunity to share information.

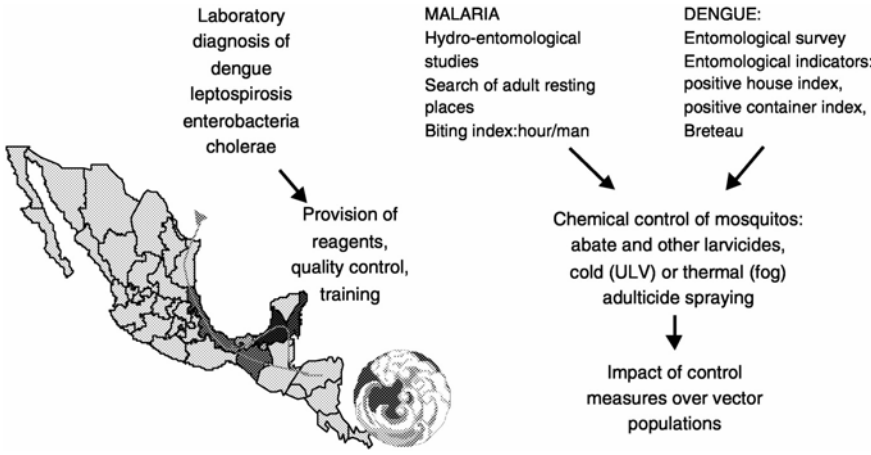

FIGURE 8 Suveillance in response to natural disaster. "Operativo Frontero Sur" XII/ 98–III/99: Campeche, Chiapas, Quintana Roo, Tabasco and Veracruz. SOURCE: INDRE.

Although that part of the world does not face the same types of infectious disease problems found in Asia and Latin America, it has a unique set of infectious disease issues with which it must contend. For example, in Sarajevo, Bosnia-Herzegovina, and other parts of Eastern Europe in 1993–1994, WHO had to establish new communicable disease surveillance because of anxieties about the re-emergence of some diseases, in particular, typhus, diphtheria, and TB (see Chapter 5).

The capacity to enhance communicable disease control efforts in Europe was further advanced by the Delphi technique for consensus building. Data information and exchange that provide an earlier warning and detect infectious disease threats that require international coordinated action were identified and evaluated at the national levels. Questionnaires and feedback rounds circulated among a group of experts from individual European countries were among the data collection methods used. The results of the Delphi exercise were submitted to the European Commission (EC) as part of its expert advice to EC members on the development of communicable disease surveillance at the European level. Influenza was ranked among the high-priority diseases requiring international surveillance.

DOD is establishing a syndromic surveillance system called the Early Warning Outbreak Recognition System, in Indonesia. Once every 24 hours several sites around the Indonesian archipelago report data on clinical syndromes to a central point in Jakarta, where a DOD laboratory is collocated with the Indonesian Ministry of Health. The system is conducted out of hospitals located around Indonesia, where nurses collect syndromic data from patients. These data are entered into a database into which one can enter not only the signs and symptoms but also the specific working diagnosis. In close to real time the frequencies of various syndromes can be tracked across the Indonesian archipelago.

Emerging infections require substantial multisectoral and multinational approaches, as well as sufficient funds. Additional examples of collaborative efforts and the various mechanisms by which they can be achieved are described below.

Cooperation Across Borders

Nations that share borders are sometimes the most logical place to initiate efforts. For example, the CDC Division of Quarantine is collaborating with Mexico on a pilot sentinel surveillance project along the U.S.-Mexico border for febrile exanthemas and hepatitis. This effort aims to strengthen the sensitivity of infectious disease surveillance through the observation of clinical syndromes and to enhance the public health capacity along the border through surveillance efforts at the provider level. A binational notification process informs the appropriate officials in each country of any reported infections. The protocol calls for rapid local, regional, and national sharing of information about sentinel cases of

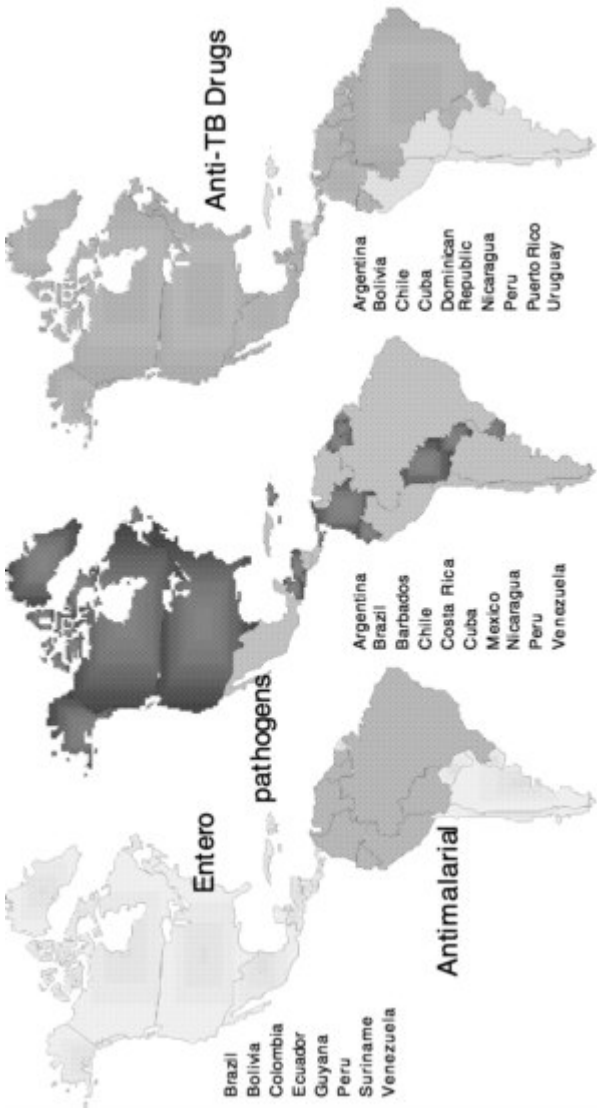

FIGURE 9 Regional CD surveillance. Countries participating in drug resistance surveillance. SOURCE: PAHO/WHO.

illness or disease that meet either country's notification requirements. Similarly, Brazil and Argentina are investing in strengthening a network of laboratories.

The trend toward globalization of public health is not without its problems. Some countries believe that these efforts undermine their ability to protect the health of their citizens or to retain state sovereignty. Some countries are concerned about the diminishment of their authority within their own territories. This can be especially contentious among bordering countries. Thus, international and national laws,

regulations, and practices must be understood and discussed in the context of establishing cooperative efforts. Local needs must be recognized and addressed.

Bilateral Agreements

In recent years the U.S. and South African governments have discussed the issues of AIDS and TB at key bilateral and multilateral meetings. Similarly, in bilateral meetings with Russia, the United States has raised awareness of TB and promoted the use of directly observed treatment (short course), an inexpensive strategy for the detection and treatment of TB. Emerging infectious diseases have also been discussed under the Asian-Pacific Economic Cooperation (APEC), as well through the U.S.-European Union New Transatlantic Agenda. Discussions surrounding debt relief at trade summits have identified the health care system as a priority for infrastructure development in the poorest countries.

Bilateral and multilateral trade agreements signed between Argentina and its neighboring countries (Bolivia, Brazil, Chile, Paraguay, and Uruguay) have included health protection components. Since the 1970s, emphasis has been given to health of the populations within the borders of each country, and internationally agreed upon health care and safety standards (see Chapter 2).

International Health Regulations

In 1969, the International Health Regulations aimed to ensure maximum security against the international spread of diseases with minimum interference with world trade, tourism, and business. The regulations set out a series of guidelines for monitoring and surveying the normal ports of a vector's entry into countries (airports, seaports) so that agents that might arrive on conveyances do not spread from the port area. The regulations require reporting of a relatively small number of infectious diseases: yellow fever, cholera, and plague. There are disincentives to reporting, which diminish the value of the program. For example, when cholera has been reported, some countries have erected economically damaging trade barriers around the country that reported cholera. Furthermore, reporting does not always result in a response.

New regulations are being drafted that will cover more infectious diseases and that will require electronic communication among quarantine officers. Ef

forts are being made to increase the response capabilities of all countries and to decrease the stigma of reporting. Critical aspects of international collaboration are establishing trust and harmonizing epidemiological and laboratory practices. Conflicts can arise around jurisdictions, costs, and international politics. Furthermore, countries have different traditions in terms of accountability and data dissemination that must be acknowledged. In addition, conflicts among international agencies and with nongovernmental organizations (NGOs) will inevitably occur. The potential for disagreement must be recognized and dealt with early in the course of an infectious disease outbreak.

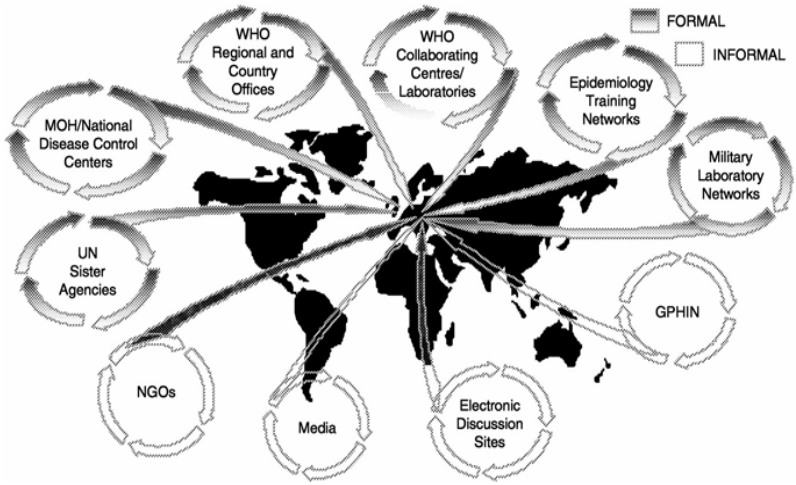

FIGURE 10 Global surveillance of communicable diseases: a network of networks. SOURCE: WHO/CDS.

NETWORKS OF GLOBAL SURVEILLANCE

Current global surveillance comprises a network of networks (Figure 10), as well as electronic discussion sites and the media. Some of these are laboratory networks, others are epidemiology training networks, and still others are reporting networks. Between November 1996 and June 1998, 260 outbreaks were reported through these networks. Once they are validated, reports of the outbreaks are distributed to a limited number of health professionals to improve the level of awareness of reported outbreaks that might have international implications. The new international health regulations may require that some actions be taken against countries that are not reporting.

Global Epidemic Intelligence, established by WHO in 1996, was created to improve international preparedness for epidemics by sharing the same information in a timely fashion, thereby countering confusing information that may be

disseminated. Confusion can have a major impact on the international prevalence of a disease. Through active collection of information about ongoing outbreaks worldwide, including validation of the sources of information and the rapid verification of the outbreak, WHO is able to share this information with those who need to know. The Internet provides an unprecedented opportunity for information sharing.

Efforts are under way to establish networks for the surveillance of emerging infectious diseases in nine countries of the Amazon Region and the Southern Cone Region. A plan of action was developed for each region in collaboration with international reference centers, including CDC, the University of Texas Medical Branch at Galveston, and the U.S. Army Medical Research Institute of Infectious Diseases. The network should be able to perform active surveillance on the basis of a syndromic approach. Five disease syndromes were selected for both regions, and two additional ones were recommended for the Southern Cone Region. The five syndromes are undifferentiated febrile syndrome, hemorrhagic fever, febrile icteric syndrome, acute respiratory distress syndrome, and sudden unexplained death.

The WHO Global Influenza Surveillance Program, now 50 years old, was responsible for the early identification of the H5N1 influenza A virus, as well as the H9N2 virus that occurred later. The program has served as a model for many surveillance programs established in subsequent years. It is an action-oriented program. Because WHO must issue recommendations for the composition of influenza vaccines twice a year—once for the Northern Hemisphere in February and once for the Southern Hemisphere in September—data must be gathered throughout the year. The infrastructure in place allows the identification of new variants, whether they are new epidemic variants or new variants with pandemic potential. The infrastructure rests on a number of national influenza centers that serve as the key laboratories for the isolation and identification of influenza viruses, using a kit of reagents produced by CDC and distributed globally. The laboratories also collect epidemiological information for transmittal to WHO headquarters in Geneva. International collaborating centers conduct comparative analyses of influenza viruses from all over the world. Collaboration with industry is essential because the strains that are identified as vaccine candidates are provided free of charge to the pharmaceutical industry for vaccine production.

In September 1998, the European Parliament and the Council of Europe agreed to establish a network for the epidemiological surveillance and control of communicable diseases in the community. This effort, which became active in July 1999, builds on an established set of networks for individual diseases such as travel-related Legionnaire's disease, HIV/AIDS, and TB, networks for drug resistance surveillance and the EntreNet for enteric organisms. National surveillance institutes have collaborated in looking at standards for surveillance. A field epidemiology training program, European Programme for Intervention Epidemiology Training, trains people in the science of epidemiology and estab

lishes communication among public health authorities from different countries. Regular surveillance bulletins in both paper and electronic form have been produced. In addition, inventories of capacity and capabilities across Europe have been generated, including a directory of vaccination policies.

Despite these multiple national and international efforts, existing and planned networks focus on known infectious diseases, which means that new agents may go undetected. A future challenge will be to transform established methods and infrastructures to detect and respond to known diseases and novel infectious agents. DNA sequence-based analysis, polymerase chain reaction-based analysis, and multicomponent-array chips will increasingly allow rapid identification of stray nonhuman DNA that is present in internal organs or blood. Deployment of these technologies will require money and awareness.

Continuing Need for Local Surveillance

Even with extensive intranational and cross-national cooperation, local surveillance remains the most important function in the early warning of and response to infectious diseases. At the local level, disease intelligence functions enhance the ability to assess indicator events. Individuals in charge of surveillance systems at the local level must work closely with their colleagues in the agricultural and veterinary sciences and those who are conducting disease surveillance in related fields. These systems must also adapt to changing patterns of health care, for example, the trend toward patients calling nurses for assistance rather than visiting a general practitioner's office, where surveillance data might be collected. Local efforts need to be integrated so that local, national, and international efforts are not competing or being duplicated. Databases must be interrelated and designed so that they can be linked while protecting confidentiality and privacy.

Local efforts also reveal much about behavioral change measures that might be required. For example, revised guidelines for dengue control elevate behavioral change indicators to the same level as entomological or epidemiological indicators, using as a model behavioral surveillance for HIV/AIDS. This requires more bottom-up surveillance programs, modeled after many nutrition and child health programs, in which indicators can be used at the household level; for example, households can determine whether removing domestic containers that may be sources of mosquito breeding is either improving the dengue situation or making the dengue situation worse. This is an important approach, as it paves the way for consumer-based control measures for other diseases, such as the use of insecticide-treated mosquito nets or the use of domestic aerosols for the control of malaria in Africa.

NGOs can play a progressive role in this area by being proximate to the problem and, through advocacy, ensure that infectious disease control issues are placed on local, national, and international agendas. NGOs can develop pilot

programs, conduct assessments, provide training, and contribute to the wider implementation of surveillance and control efforts. Accordingly, NGOs must have access to affordable and essential drugs and must have sustained financing to support long-term intervention activities and programs.

Preservation of Samples

The availability of archived biological samples can facilitate understanding of new pathogens and can speed the response to outbreaks. Therefore, more countries must be encouraged to preserve blood and tissue specimens, whether from zoonotic or human events, to make it feasible to search for specific susceptibility factors. For example, an outbreak of viral encephalitis caused by the previously unrecognized Nipah virus occurred in Malaysia in 1998. The ability to analyze archival collections of serum samples from pigs collected in Malaysia in 1995 showed that some porcine samples had antibodies to Nipah virus. This allowed investigators to conclude that the virus had been circulating in the population for some time.

A large and invaluable resource of archived samples is DOD's triservice serum repository, begun in 1985, which contains 25 million specimens collected from military personnel. This resource serves many research needs; it most recently provided important information on hantavirus from samples obtained from military recruits from the southwest United States.

Using the Internet for Reporting and Communication

The Internet is providing a whole new means for the posting of disease alerts and information about new therapies and technologies, informing public health officials about relevant meetings, and providing new opportunities for collaboration. The Internet is increasingly being used as a source of outbreak-related information through media newswires, electronic discussion groups, and websites. Quality assurance, however, is an important requirement for officials using worldwide web-based information as a source of infectious disease information.

To explore the extent to which this form of nontraditional reporting can be channeled for good use, WHO developed with the Canadian Ministry of Health a computer application that scans thousands of websites 10 times a day, including media newswires, for information that could lead to a report or reports of communicable diseases or disasters. This information is then transmitted to WHO. The Global Public Health Intelligence Network serves as an example of an innovative new approach to surveillance. Of about 450 outbreaks verified in the past 2.5 years, more than 50 percent of the reports came from the media. “Hits” gathered from websites are then monitored to obtain more detailed in

formation. This information is entered into a database that also contains data from more traditional reporting mechanisms.

TAKING ADVANTAGE OF WINDOWS OF OPPORTUNITY

Too often, delayed responses to outbreaks and the spread of infectious diseases result in missed opportunities for treatment and control. Lessons from the past should teach people today about the dangers of missing important openings for intervention. For example, in Africa the rates of resistance patterns to penicillin and tetracycline by the organism that causes gonorrhea are on the rise. In the 1950s and 1960s, when the prevalence of gonorrhea throughout African countries was extremely high governments did not attempt to change behavior or offer treatment. Had public health education been offered back in the 1960s and had antibiotics been used effectively, gonorrhea would not be present to the same extent throughout Africa today and would not be causing needless suffering and infertility in women. Today, HIV poses a similar new challenge, as several African countries have infection rates of greater than 25 percent. Many believe that the opportunity to halt the spread of this deadly virus has already been missed.

Fighting the global spread of infectious disease takes political resolve and sufficient financial resources, just as eradication of smallpox did. In many cases, the tools required to detect, isolate, and control microbial agents are available but are underused or inaccessible. For example, measles vaccination rates in Africa range from 19 to 90 percent. A vaccine exists for hepatitis B and *Haemophilus influenzae* type B infection, yet the perception of the burdens of these diseases relative to those of other diseases and the costs of vaccines against both pathogens has led to their low level of use. The health system required to deliver these vaccines needs to be strengthened. In addition, government policies that can lead to the censuring of information about the extent to which a disease such as HIV/AIDS is present in the population undermine disease surveillance and control activities.

Some parts of the world are ripe for intervention. For example, there is an enormous need and opportunity to introduce new infectious disease control infrastructures into the Central Asia republics and Russia because their relatively new state of independence has left them with no experience in international procurement and self-governance. For example, they lack the logistical wherewithal to purchase reagents or vaccines or implement directly observed therapy. USAID, CDC, the Soros Foundation, and WHO have been collaborating to bring the necessary resources to these evolving health care systems.

The eradication of smallpox, which was declared in 1980, serves as an example of an effective worldwide effort to engender political will and muster resources. The disease, which was causing as many as 1.9 million deaths a year

by the late 1960s, was eradicated because of concerted efforts to further develop an effective vaccine and to create a global infrastructure for its distribution and for smallpox surveillance. Today, the use of linkages through the Internet offers several possibilities for faster reporting and faster responses to disease threats. It must be recognized, however, that even the fundamental tools needed to capitalize on new information technologies may not be available in some of the developing countries, and training workshops are needed when new tools are introduced.

Although many developing countries are aiming for self-sufficiency in developing, storing, and maintaining necessary supplies of reagents and in-country expertise, organizations such as CDC, WHO (including PAHO and other regional offices), USAID, and NGOs will be needed to supply routine diagnostic reagents, provide training, enhance communication, and exert quality control. More structured agreements are needed to ensure that the requisite laboratories are adequately equipped and that channels of communication are left open.

A structured agreement that could bring technology transfers, communication, and reporting into a coordinated program to strengthen public health laboratories and surveillance is the Biological Weapons Convention. Article X of the Convention requires that the signatories exchange technologies. This would improve the diagnostic capabilities of laboratories and improve information sharing. These enhanced capabilities could also add to those resources used to support the public health capabilities of laboratories in other countries. Similarly, the medical research laboratories of overseas military assets can help local civilian medical communities find ways to adapt the many new and emerging detection technologies to infectious disease surveillance. Training and education activities sponsored by the military could also be coordinated with those programs administered by the public health infrastructures of governments and NGOs.

To achieve an integrated system of surveillance and monitoring with an appropriate and timely response, the world community must work toward the following common goals:

- Strengthening disease surveillance of humans and domestic animals. Priority areas include improving communication and information sharing between the medical and veterinary communities and designing integrated medical and veterinary disease surveillance systems at the regional level.
- Building on existing disease-specific reporting systems. Consider the use of novel technology, such as remotely sensed data, in existing disease surveillance systems and expand disease-specific surveillance systems to monitor other closely related diseases.
- Enhancing and improving the use of communication and information Technologies.
- Promoting the International Health Regulations.
- Developing improved, low-cost laboratory infrastructure for surveillance.

- Fostering good public health practices.
- Training personnel.
- Educating the public and professionals to slow the rate of increase of antimicrobial resistance.
- Conducting collaborative research. Priority areas for investigation include preventing the development of drug-resistant microbes by promoting the appropriate use of antibiotics; understanding the transmission patterns of food-, water-, vector-, and air-borne pathogens; and improving diagnostic tests and prevention and control strategies for infectious diseases.
- Accelerating vaccine development and distribution.
- Fostering credible coordinating international groups.
- Encouraging overseas institutions, such as military medical research units, to be more involved in helping the host country develop an infectious disease surveillance infrastructure.

All nations should promote the participation of the health sector in international trade agreements that may affect human, animal, or plant health. This requires a commitment at the highest levels of government to improve the components of the global surveillance system, upgrading the infrastructure and the qualifications of the human resources needed to control emerging infections, and supporting and encouraging rapid intra- and intercountry communications on health issues, including infectious disease outbreaks. This kind of high-level dialogue must be intentional and ongoing. Outreach to countries not involved in international discussions on disease surveillance is especially important, as they are most likely at high risk for infectious disease outbreaks. Within and across borders there must be integration of the public health system, epidemiologically, building on the laboratory and the clinical health care base. This requires efforts at the local level.

Economic globalization, demographic changes, and the increased costs of infectious disease control and prevention for human health and welfare emphasize the interdependence of all nations. As efforts are made to improve trade and bring democratic governance to countries in the developing world, the crucial needs of public health cannot be forgotten. Strengthened national and regional public health systems not only will reduce the level of human suffering from infectious diseases but also can promote economic growth and political stability among those countries most affected.

EMERGING INFECTIOUS DISEASES FROM THE GLOBAL TO THE LOCAL PERSPECTIVE

A Summary of a Workshop of the Forum on Emerging Infections

Jonathan R. Davis and Joshua Lederberg, *Editors*

Board on Global Health
INSTITUTE OF MEDICINE

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—Goethe

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All presenters at the workshop have reviewed and approved their respective sections of this report for accuracy. In addition, this workshop summary has been reviewed in draft form by independent reviewers chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the Institute of Medicine (IOM) in making the published workshop summary as sound as possible and to ensure that the workshop summary meets institutional standards. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

The Forum and IOM thank the following individuals for their participation in the review process:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Adel A. F. Mahmoud, M.D., Ph.D., President, Merck Vaccines, Merck and Co., Inc., Whitehouse Station, New Jersey, who was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the editors.

Preface

The Forum on Emerging Infections was created in 1996 in response to a request from the Centers for Disease Control and Prevention and the National Institutes of Health. The goal of the Forum is to provide structured opportunities for representatives from academia, industry, professional and interest groups, and government* to examine and discuss scientific and policy issues that are of shared interest and that are specifically related to research and prevention, detection, and management of emerging infectious diseases. In accomplishing this task, the Forum provides the opportunity to foster the exchange of information and ideas, identify areas in need of greater attention, clarify policy issues by enhancing knowledge and identifying points of agreement, and inform decision makers about science and policy issues. The Forum seeks to illuminate issues rather than resolve them directly; hence, it does not provide advice or recommendations on any specific policy initiative pending before any agency or organization. Its strengths are the diversity of its membership and the commitment of individual members expressed throughout the activities of the Forum.

A critical part of the work of the Forum is a series of workshops. The first of these, held in February 1997, addressed the theme of public- and private-sector collaboration (IOM, 1997). The second workshop took place in July 1997 and explored aspects of antimicrobial resistance (IOM, 1998). The third workshop (IOM, 2000a) examined the implications of managed care systems and the

*Representatives of federal agencies serve in an *ex officio* capacity. An *ex officio* member of a group is one who is a member automatically by virtue of holding a particular office or membership in another body.

ability to address emerging infectious diseases in the age of managed care. The fourth workshop (IOM, 2000b) examined the core capacities of the public and private health sectors in emerging infectious disease surveillance and response. The fifth workshop, held in October 1999, which this document summarizes, examined the international aspects of emerging infections and the forces that drive these diseases to prominence from the global to the local levels. The topic of zoonotic diseases was the focus of the Forum's sixth workshop, which was held in June 2000. The summary of that workshop is in production. The next workshop sponsored by the Forum will address factors surrounding viral disease eradication.

ABOUT THE WORKSHOP

In recent years, emerging infections have captured increased attention internationally. This comes at a time when other diseases are gaining in importance. In an effort to increase our knowledge and understanding of the current and probable future public health significance of emerging infections internationally, the Institute of Medicine's Forum on Emerging Infections hosted a 2-day workshop on October 28 and 29, 1999, titled “International Aspects of Emerging Infections.” The goal of the workshop was to collect new information on this topic from public health practitioners, academicians, and policy makers at the global, regional, national, and local levels from various geographical areas. Their presentations focused on the interplay among emerging infections, economics and trade, public health policies, population and demography, strategic planning and resource allocation, and infrastructure and capacity at their positions of practice. Panel discussions then focused on the interaction of these factors with infectious disease surveillance and response, communication and coordination, and research and training needs with recognition of the lessons and mistakes learned in the process and identification of novel approaches and obstacles at each level. Through the presentations and discussions, we hope to gain new insight into

- the forces that drive the policies of governments and international organizations;
- the ways in which diseases are prioritized; and
- the strengths and weaknesses of past and current local, national, and multinational efforts to effectively bring nations and international organizations closer together to mitigate the impacts of emerging infections.

Early-on during the workshop, it was clear that the infrastructure and level of support for surveillance, research, and training on emerging infectious diseases varied widely across geographic regions. For example, in many countries a shrinking number of trained infectious disease specialists was cited. The latter

point was accentuated while developing the workshop as some of the foreign scientists invited to make presentations were unavailable owing to exigent schedules and demanding workloads for the qualified few, in addition to difficulty in obtaining government permission to travel and technological obstacles to effective communication. Consequently, although the presentations were rich and wide-ranging, the workshop did not support a comprehensive and balanced treatment of issues across regions.

ORGANIZATION OF WORKSHOP SUMMARY

This report of the Forum-sponsored workshop is prepared in the form of a workshop summary by and in the name of the editors, with the assistance of staff and consultants, as an individually authored document. Sections of the workshop summary not specifically attributed to an individual reflect the views of the editors and not those of the Forum on Emerging Infections or its sponsors. The contents of the unattributed sections are based on the presentations and discussions that took place during the workshop.

The workshop summary is organized as a topic-by-topic description of the presentations and discussions. Its purpose is to present lessons from relevant experience, delineate a range of pivotal issues and their respective problems, and put forth some potential responses as described by the workshop participants. The Summary and Assessment chapter discusses the core messages that emerged from the speakers' presentations and the ensuing discussions. Chapter 1 is an introduction and overview of the international perspective on confronting emerging infections. Chapter 2, Chapter 3, Chapter 4 and Chapter 5 begin with overviews provided by the editors, followed by the edited presentations made by the invited participants. Appendix A is a glossary and list of acronyms useful to the reader. Appendix B presents the workshop agenda. A list of workshop participants is found in Appendix C. Forum members and staff biographies are presented in Appendix D.

Although this workshop summary provides an account of the individual presentations, it also reflects an important aspect of the Forum philosophy. The workshop functions as a dialogue among representatives from different sectors and presents their beliefs on which areas may merit further attention. However, the reader should be aware that the material presented here expresses the views and opinions of those participating in the workshop and not the deliberations of a formally constituted Institute of Medicine study committee. These proceedings summarize only what participants stated in the workshop and are not intended to be an exhaustive exploration of the subject matter.

ACKNOWLEDGMENTS

The Forum on Emerging Infections and the Institute of Medicine (IOM) wish to express their warmest appreciation to the individuals and organizations

who gave valuable time to provide information and advice to the Forum through participation in the workshop.

The Forum is indebted to the IOM staff who contributed during the course of the workshop and the production of this workshop summary. On behalf of the Forum, I gratefully acknowledge the efforts led by Jonathan Davis, study director for the Forum and coeditor of this report, who dedicated much effort and time to developing this workshop's agenda and for his thoughtful and insightful approach and skill in translating the workshop proceedings and discussion into this workshop summary. I would also like to thank the following IOM staff for their valuable contributions to this activity: Vivian Nolan assisted with the development of the workshop agenda, Thelma Cox assisted with editing various sections of the workshop summary list and provided comprehensive administrative support and Nicole Amado assisted in developing the glossary and acronyms in Appendix A. Other IOM staff also provided invaluable help: Sue Barron, Clyde Behney, Claudia Carl, Michael Edington, Carlos Gabriel, and Andrew Pope. Kathi Hanna, a consultant and technical writer contributed significantly to writing many sections of the workshop summary. The extensive commentary and suggestions made by the copy editor, Michael Hayes, are gratefully acknowledged.

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Joshua Lederberg
Chair

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