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GLOBAL HEALTH

Challenges in Improving Infectious Disease Surveillance Systems

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Abbreviations

CDC	Centers for Disease Prevention and Control
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IDS	Integrated Disease Surveillance and Response
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

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United States General Accounting Office
Washington, DC 20548

August 31, 2001

The Honorable Patrick Leahy
Chairman
The Honorable Mitch McConnell
Ranking Minority Member
Subcommittee on Foreign Operations
Committee on Appropriations
United States Senate

The Honorable Russell Feingold
Chairman
The Honorable Bill Frist
Ranking Minority Member
Subcommittee on African Affairs
Committee on Foreign Relations
United States Senate

According to the World Health Organization, infectious diseases account for more than 13 million deaths every year, including nearly two-thirds of all deaths among children under age 5. Although the great majority of these deaths occur in developing countries, infectious diseases do not recognize international boundaries. They present a substantial threat to people in all parts of the world. In recent years, this threat has grown in volume and complexity. New diseases have emerged, others once viewed as declining in significance have resurged in importance, and many have developed substantial resistance to known antimicrobial drugs. This picture is complicated by the potential deployment of infectious disease pathogens as weapons of war or instruments of terror.

Infectious disease surveillance provides national and international public health authorities with information that they need to plan and manage efforts to control these diseases. In the mid-1990s, public health experts in the United States and abroad determined that global infectious disease surveillance was inadequate, and both the World Health Assembly and the

President of the United States called for concerted action to develop an effective global infectious disease surveillance and response system.[1]

In response to your concern about current arrangements for infectious disease surveillance, we reported in July 2000[2] that global surveillance is carried out through a loose framework of formal, informal, and ad hoc arrangements that World Health Organization (WHO) officials characterize as a "network of networks." In this second report, we (1) examine the framework's evolution and current operations, (2) identify factors that constrain its performance, and (3) assess several initiatives designed to improve global infectious disease surveillance and response.

In doing this work, we collected data from and consulted with experts in the international public health community, including officials of WHO, the Centers for Disease Control and Prevention (CDC), the U.S. Agency for International Development (USAID), the World Bank, and prominent nongovernmental organizations in the health sector. As you requested, we emphasized surveillance operations in sub-Saharan Africa, visiting Malawi, Tanzania, Uganda, and Zimbabwe to discuss relevant issues with public health officials at every level. More detailed information about our scope and methodology is in appendix I. Information on each of the diseases mentioned in this report is in appendix II.

Results in Brief

The strongest influence on the evolution of the current global infectious disease surveillance framework has been the international community's focus on specific diseases or groups of diseases. The international community has created diverse surveillance programs to support global and/or regional efforts to control particular diseases. The longest standing of these is the global influenza program, which was launched prior to the WHO's founding in 1948. The success of the intensified smallpox

[1]See World Health Assembly Resolution 48.13, Communicable Disease Prevention and Control: New Emerging and Re-Emerging Infectious Diseases (Geneva, Switzerland: May 12, 1995); *Emerging Infections: Microbial Threats to Health in the United States*, Institute of Medicine (Washington, D.C. 1992*); Infectious Disease—A Global Health Threat*, Report of the National Science and Technology Council, Committee on International Science, Engineering, and Technology, Working Group on Emerging and Re-emerging Infectious Diseases (Washington, D.C.: Sept. 1995); and Presidential Decision Directive NSTC-7, Emerging Infectious Diseases (Washington, D.C.: June 1996).

[2]*Global Health: Framework for Infectious Disease Surveillance* (GAO/NSIAD-00-205R, July 20, 2000).

eradication effort, which began in 1966 and identified the last naturally occurring case in 1977, spurred initiation of other eradication/elimination efforts during the late 1980s and early 1990s, including the current campaign to eradicate polio. International public health officials also operate a number of programs directed at controlling noneradicable diseases such as dengue. Under some circumstances, such as when a disease can be eradicated with comparative ease or when it poses a high risk of a global pandemic, disease-specific programs have attracted broad support and substantial funding. In such situations public health officials have been able to establish specific goals and create comparatively high-performing systems—including surveillance systems—to support achievement of those goals. Surveillance for other diseases has received less international support and is more limited.

Surveillance systems in all countries suffer from a number of common constraints. However, these constraints have their greatest impact in the poorest countries, where per capita expenditure on all aspects of health care amounts to only about 3 percent of expenditure in high-income countries. Surveillance in developing countries is often impaired by shortages of human and material resources. Key positions in laboratories and clinics often are filled by people who do not possess the necessary qualifications. According to WHO, staff in over 90 percent of developing country laboratories are not familiar with quality assurance principles, and more than 60 percent of laboratory equipment is outdated or not functioning. Sixteen of 19 WHO-sponsored assessments of sub-Saharan African systems that we reviewed reported weaknesses in laboratory capacity, ranging from a lack of trained technicians to deteriorating buildings. In addition, poor roads and communications make it difficult for health care workers to alert higher authorities about outbreaks or quickly transport specimens to laboratories. Ten of the assessments found that less than half of the local health facilities surveyed had operating telecommunications equipment or vehicles for transport. In addition, multiple surveillance systems are often poorly coordinated and not firmly linked to response measures. The absence of a clear response discourages lower level officials from investing effort in surveillance, and this leads to many cases of disease going unrecorded and unreported. These weaknesses limit the effectiveness of even the most widely supported international disease control programs. They also impair routine surveillance for other diseases and efforts to investigate and respond to outbreaks, newly emerging diseases, and growth in antimicrobial resistance.

The international community has recently launched a number of initiatives that may improve global surveillance. First, the community has committed itself to achieving specific reductions in the global burdens imposed by three diseases—tuberculosis, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), and malaria—that present complex challenges. Improving surveillance for these three diseases will be an essential part of the global response to these new commitments. Second, the community has launched more broadly targeted initiatives to upgrade laboratories, strengthen epidemiological capacity, and otherwise improve surveillance for infectious diseases as a group. The eventual impact of both the disease-specific and the more broadly targeted initiatives remains to be demonstrated. Public health experts observed that major reductions in tuberculosis, HIV/AIDS, and malaria cannot be achieved without substantial overall improvements in developing country health systems, including surveillance operations of these systems. These new disease-specific initiatives may therefore facilitate efforts to improve surveillance for infectious diseases as a group. Nonetheless, efforts to make broad improvements in developing country systems will be proceeding in an environment wherein the priority will be to achieve measurable results against HIV/AIDS, malaria, and tuberculosis, in particular. The extent to which the global public health community's response to the new disease-specific commitments will improve surveillance for all infectious diseases remains to be seen.

We received comments on a draft of this report from the Department of Health and Human Services (which includes CDC), and the Departments of Defense and State, as well as from WHO, USAID, the National Aeronautics and Space Administration, and the World Bank. These agencies generally concurred with our findings. The Department of Health and Human Services and USAID elaborated upon the challenges to be faced in developing programs to improve surveillance and response capacity for specific diseases and for infectious diseases as a group, while USAID and the Department of Defense commented that the report did not adequately describe their contributions to improving global surveillance. We modified this report to respond to these comments and to other matters raised by the agencies.

Background

Dramatic increases in the volume and speed of international travel and trade in recent years have increased opportunities for diseases to spread across international boundaries. The global reach of the ongoing HIV/AIDS pandemic and the recent appearance in the United States of West Nile virus—a pathogen never before identified in the Western Hemisphere—

demonstrate this point. Diseases once regarded as declining in significance have also reemerged in recent years to once again become major global health threats. For example, according to WHO, global reports of yellow fever have dramatically increased over the last 2 decades.

The emergence of previously unknown diseases and the development of disease strains resistant to antimicrobial drugs further complicate international disease control efforts. Over the past 3 decades, more than 30 previously unknown diseases have been identified. Many, including Ebola hemorrhagic fever, Rift Valley fever, and Lyme disease, appear to have become threats to human health because of increased human movement into or alteration of the habitats of disease-carrying insects and animals. Excessive, uncontrolled use of antimicrobial drugs has contributed to the evolution of disease strains that are highly resistant to available medications.

Infectious diseases can be a substantial obstacle to economic and social advancement in developing countries, where the great majority of cases of such diseases occur. For example, WHO has concluded that Africa's gross domestic product would be nearly one-third higher than it is today if malaria alone had been eliminated 35 years ago. Development experts believe that the HIV/AIDS pandemic will have a similar impact on African economies.

Surveillance provides information for action against infectious disease threats. Basic surveillance functions include detecting and reporting cases of disease, analyzing and confirming this information to identify outbreaks and clarify longer-term trends, and applying the information to inform public health decisionmaking. When effective, surveillance can facilitate (1) timely action to control outbreaks, (2) informed allocation of resources to meet changing disease conditions, and (3) adjustment of disease control programs to make them more effective. According to CDC, factors that can be taken into account in evaluating surveillance systems include their ease of operation; the extent to which health care providers and laboratory personnel actually provide the system with information; and the system's ability to identify cases of disease, accurately diagnose them, and generate timely and accurate information on disease events and trends.

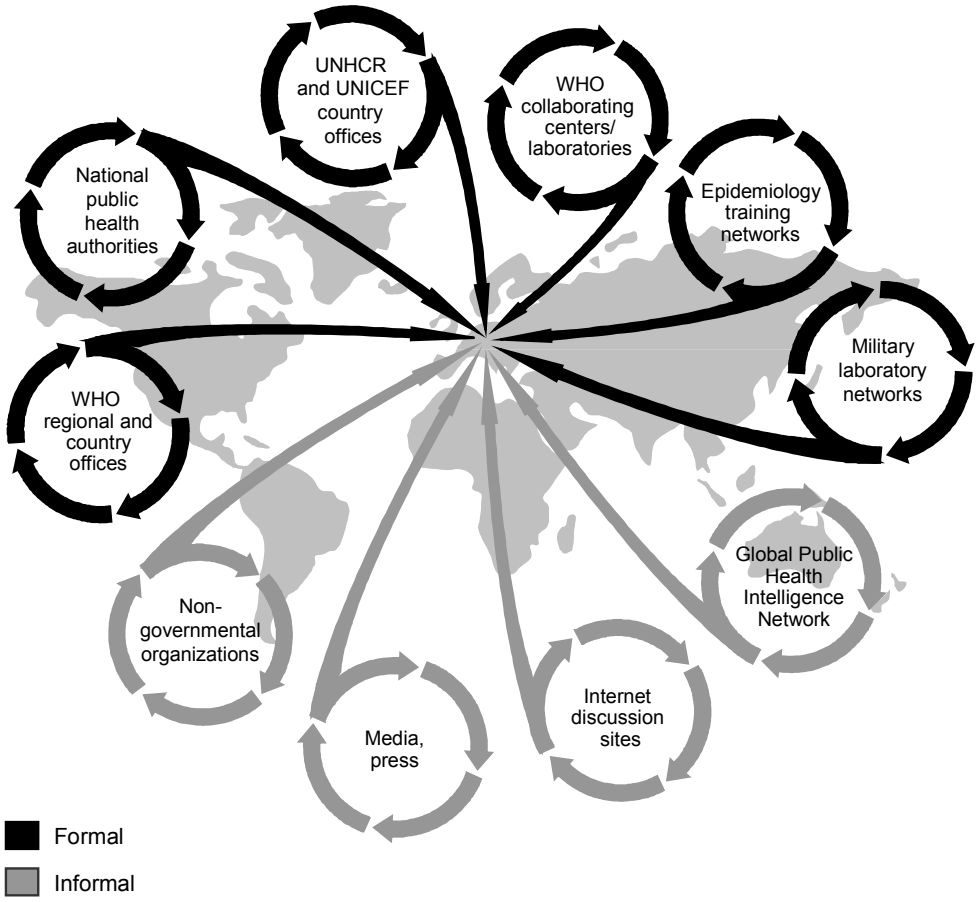
Basic responsibility for disease surveillance and response lies with individual countries. The legal underpinnings for cooperation among countries to control infectious diseases are limited in scope. The primary function of the International Health Regulations—the most important and

only binding international agreement on disease control—is to delineate measures that countries may take to protect themselves against epidemics of three diseases: cholera, plague, and yellow fever.[3] To provide national authorities with a basis for applying protective measures, the regulations require countries that record cases of these three diseases to report to WHO, which then makes that information available to other countries. The Regulations do not provide an international framework for addressing threatening epidemics at their source—within countries.

At the global level, surveillance functions are carried out through a loose framework that links elements of national health care systems with various entities, including media channels, nongovernmental organizations active in health, and laboratories and other institutions participating in networks focusing on particular diseases and/or regions. Figure 1 presents one illustration of this global "network of networks." The groupings presented in this figure are not mutually exclusive. For example, national public health authorities may operate WHO Collaborating Centers, participate in epidemiology training networks, and maintain Internet discussion sites.

[3]The origins of the International Health Regulations can be traced back to the 1892 adoption of the first International Sanitary Convention, which only addressed cholera. The original convention has been revised and replaced on several occasions, with the term "International Health Regulations" introduced in 1969. The Regulations were last revised in 1981 when smallpox reporting was eliminated due to the success of the global smallpox eradication program. A total of 187 countries have agreed to comply with the Regulations in full. Australia is the only WHO member country that has not accepted the Regulations. Seven countries—Egypt, India, Iran, Libya, Madagascar, Pakistan, and Papua New Guinea—have accepted them in part, or with reservations.

Figure 1: The Global Infectious Disease Surveillance Framework: A Network of Networks



Note 1: UNHCR represents the United Nations High Commissioner for Refugees.

Note 2: UNICEF represents the United Nations Children's Fund.

Source: WHO.

WHO plays a central role in the surveillance framework by working to strengthen national and international surveillance capacity and coordinating international efforts to monitor disease trends, detect and respond to outbreaks, and carry out disease control programs. Foreign assistance agencies such as the World Bank and USAID, as well as private foundations, are important sources of support for strengthening surveillance operations, particularly those taking place in developing

countries. For example, in commenting on a draft of this report, the World Bank noted that it is actively working with a number of developing country governments to strengthen their national surveillance systems, within the context of the Bank's overall emphasis on health. While many technical agencies contribute to framework operations, CDC is the single largest source of expertise and resources available to the international surveillance and response system. The Department of Defense also contributes to global surveillance through its Global Emerging Infections Surveillance and Response System.[4] In commenting on a draft of this report, for example, the department cited its contributions to global surveillance for drug-resistant malaria and influenza.

Global Surveillance Varies by Disease

The global surveillance framework's capacity for serving the public interest varies according to the level of commitment that the international community has made to controlling individual diseases or groups of diseases. The most significant influence on the framework's development has been the international public health community's focus on controlling specific diseases. In some circumstances—when a disease can be eradicated with comparative ease or when it poses a high risk of a global pandemic—these programs have attracted broad support and substantial funding. In such situations, public health officials have been able to establish specific goals and create comparatively high-performing systems—including surveillance systems—to support achievement of those goals. Surveillance for other diseases is more limited.

Multiple Surveillance Systems Created to Support Disease-Specific Control Programs

The strongest influence on the evolution of the existing surveillance framework has been the collaboration among medical professionals, national governments, and foreign assistance agencies to develop control programs and associated surveillance efforts that focus on specific diseases or groups of diseases. The longest standing of these disease-specific efforts is the global influenza program, which was launched prior to WHO's founding in 1948. Later, the success of the global effort to eradicate smallpox (1966 through 1977) spurred the creation of other programs designed to eradicate or eliminate global disease threats, such as polio and leprosy, and diseases found in specific regions, such as guinea

[4]For more information on this system, see http://www.geis.ha.osd.mil/.

worm and river blindness, which are both found primarily in Africa.[5] Global consensus in favor of these eradication/elimination campaigns was achieved during the late 1980s and early 1990s, after reduction programs had achieved substantial progress. WHO also collaborates with numerous institutions around the world to maintain programs to control noneradicable infectious diseases such as HIV/AIDS, cholera, tuberculosis, malaria, and dengue. National disease-control programs reflect this focus on specific diseases. They are generally managed through separate programs aimed at specific diseases, such as polio and tuberculosis, or groups of diseases, such as those covered by the Expanded Program on Immunization.[6]

Disease Characteristics, International Commitment Affect Surveillance Quality

Variation in the quality of global surveillance systems can be attributed in large measure to disease characteristics. Under certain circumstances—for example, if a disease can be eradicated or if it poses a high risk of a global pandemic—disease-specific control programs have attracted broad support and have employed this support to create comparatively effective surveillance systems. Surveillance for other diseases, including emerging infections, has received less international support and is more limited.

High-Quality Surveillance for Some Diseases

The best surveillance systems have been established to support international campaigns aimed at eradicating or eliminating certain diseases, including polio and guinea worm, and at protecting the global community against influenza—a disease that has the potential to inflict global pandemics.[7]

[5]Disease control initiatives can be designed to reduce the number of cases below current levels, or they may be directed at eliminating or eradicating a disease. Elimination initiatives seek to reduce the number of cases in a particular area to zero and/or to reduce morbidity to a level that does not constitute a major public health problem. Eradication initiatives seek to reduce worldwide incidence of a disease to zero, obviating the need for further control measures.

[6]In addition to serving as the vehicle for the polio initiative, the Expanded Program on Immunization generally provides vaccinations against tuberculosis, measles, tetanus, diphtheria, and pertussis (whooping cough), and can provide vaccines against other diseases such as haemophilus influenzae type B (HIB), rubella, hepatitis B, and yellow fever.

[7]For more information on influenza preparedness, see *Influenza Pandemic: Plan Needed for Federal and State Response* (GAO-01-4, Oct. 27, 2000).

The international community has been supportive of eradication/elimination campaigns because they promise dramatic results—the removal of targeted diseases as public health threats—after relatively short periods of concentrated effort. However, only diseases with certain characteristics can be eradicated or eliminated. In addition to imposing substantial disease burdens—a trait common to many illnesses—diseases that the global community has targeted for eradication or elimination tend to share other characteristics that have encouraged consensus in favor of concerted action. Although the international community has targeted other diseases for eradication or elimination, polio and guinea worm are discussed below to illustrate the characteristics of eradicable diseases and the comparatively high quality of surveillance systems that are created to support international eradication/elimination campaigns.[8]

The polio virus and the guinea worm parasite both require human hosts to complete their reproductive life cycles. Both can be controlled by interrupting their transmission from infected to uninfected individuals. Also, available diagnostic tools and approaches make these diseases relatively easy to identify and differentiate from other illnesses. For example, a small but predictable number of polio victims (less than 1 percent) develop acute flaccid paralysis—a condition in which those infected suddenly lose control of the muscles in their limbs. This makes it possible to readily identify communities where intervention may be required. Guinea worm is easily detected when mature worms emerge from infected people's bodies. Moreover, these diseases generally can be controlled through application of effective, comparatively inexpensive, and easily applied interventions. Polio, for example, can be prevented through immunization with vaccines that are available to developing countries at very low prices. Guinea worm transmission can be dramatically reduced through education and relatively cheap and simple water filtration systems.

These characteristics have allowed disease experts to develop clearly stated, technically feasible, time-limited goals and indicators for measuring progress. Advocates for campaigns against these diseases have been able

[8]Global commitments to eradicating these two diseases are of longest standing. Campaigns to eliminate river blindness, leprosy, and Chagas disease have also been under way for a decade or more. An initiative against lymphatic filiariasis was launched in 1997, and the international community is considering other global initiatives, including measles eradication.

to obtain political commitment and financial support from countries with these diseases and from public and private sources of foreign assistance. For example, the global polio eradication effort has received financial and/or technical support from the governments of the United States, Japan, Norway, Australia, Canada, Denmark, the United Kingdom, and other industrialized countries; Rotary International and other private organizations; and developing country governments.

With major financial resources[9] and support from all concerned governments, these campaigns have developed comparatively high-performing surveillance systems. For example, donors and developing country governments have combined their efforts to create a system of active surveillance[10] for acute flaccid paralysis that can promptly identify potential polio cases. This surveillance system has helped reduce the global incidence of polio by 99 percent since 1988. The surveillance effort is ambitious—most countries employ multiple surveillance officers to conduct active surveillance for cases of acute flaccid paralysis. According to CDC officials, most countries in Africa dedicate at least one motor vehicle and significant financial resources to polio surveillance. The ability to confirm the presence of the disease has been helped by creation of a global network of 148 laboratories at the national, regional, and global levels to ensure accurate diagnosis and differentiation among strains.[11] These laboratories participate in an annual accreditation program to ensure the accuracy of their analyses.

Surveillance efforts to eradicate guinea worm have been similarly ambitious. This eradication program began with comprehensive village-by-village surveys in endemic countries to identify every afflicted locality. To use these data effectively, WHO and the U.N. Children's Fund (UNICEF)

[9]In September 2000, for example, WHO reported that donor nations and agencies had indicated that they would provide approximately $550 million dollars in support for the polio eradication campaign through 2005. According to the World Bank and the Carter Center, the guinea worm eradication campaign received more than $87 million in donor support from 1987 through 1998.

[10]Passive surveillance systems rely on local health care providers to submit periodic reports on infectious disease incidence. Active surveillance is often employed to help compensate for the reporting shortfalls that are commonly encountered in passive systems. In active surveillance systems, health workers from district or national levels "make the rounds" to seek out possible cases.

[11]Differentiation among strains is valuable in determining the origins of specific cases so that response measures can be directed where needed.

created a Joint Program on Health Mapping. The "HealthMapper" project generated national and international maps of guinea worm incidence that were used to target interventions and plot progress in interrupting transmission. Endemic countries created networks of community workers in every village to report guinea worm cases so that response measures could be delivered in a timely fashion. This surveillance effort facilitated reduction of the global incidence of this disease from an estimated 10 million to 15 million cases a year in the early 1980s to about 75,000 cases in 2000 (more than two-thirds of them occurring in war-torn Sudan).

Although influenza cannot be eradicated due to its presence in a variety of animal hosts and its constantly evolving character, the international community has created an extensive surveillance system for this disease. Factors leading to the considerable level of investment in this system include the disease burdens imposed by influenza and the character of available interventions. Although often perceived as a comparatively low-level threat, the viruses that cause influenza are continually evolving and occasionally appear in highly virulent forms. For example, the 1918 to 1919 influenza pandemic killed more than 20 million people in locations as diverse as China, Spain, the United States, and Samoa. Although not as severe, influenza pandemics in 1957 and 1968 killed a total of 1.5 million people and caused an estimated $32 billion in economic losses worldwide, according to WHO. While influenza's adverse impacts can be reduced via immunization, vaccines have to be re-engineered each year to target the strains considered likely to be most prevalent in the upcoming "flu season."[12] Worldwide surveillance is necessary to permit continuous updating of the information that manufacturers use to reformulate these vaccines.

Since the late 1940s, WHO has created a global network of 111 national influenza centers in 83 countries, supported by 4 international reference laboratories.[13] These centers collaborate in collecting and analyzing influenza strains to identify those that appear most likely to spread around the globe and present major risks to public health. According to CDC, the system produced vaccines that precisely or substantially targeted 12 of 13 virus strains that circulated widely between 1988 and 1997. WHO has also

[12]In temperate countries, influenza cases are concentrated in the winter months.

[13]The international reference laboratories are operated by CDC and institutions in the United Kingdom, Japan, and Australia.

created "FluNet," an Internet site devoted to monitoring global influenza activity.

More Limited Surveillance for Other Diseases

Although diseases such as yellow fever, cholera, and dengue also present substantial public health threats, surveillance for these diseases tends to be more limited. These diseases have characteristics that work against international commitment in favor of ambitious, goal-directed control campaigns. Cholera, dengue, and yellow fever do not appear to be good candidates for eradication because the pathogens that cause them can live and reproduce without human hosts. Advocates for addressing these diseases cannot therefore hold out the prospect of eradication or elimination as an incentive for investing in control efforts.[14] Without laboratory confirmation, all three can be confused with other diseases causing similar symptoms. They are therefore comparatively difficult to identify, especially in developing country conditions. Although effective yellow fever vaccines are available, many developing country governments do not administer them routinely.[15] Cholera vaccines are infrequently employed,[16] and there is currently no vaccine for dengue. No specific treatment exists for any of the three diseases; all are treated primarily by ensuring that patients are hydrated. Therefore, although all three cause periodic outbreaks that require an organized response, health care providers may simply address patient needs without seeking laboratory confirmation of possible cases or reporting cases to higher level authorities. This reduces the likelihood that surveillance reports will accurately reflect disease incidence or trends and makes it difficult for disease campaign advocates to set specific objectives for reductions in these diseases. Finally, although all three diseases are quite serious and can spread across international borders, they do not threaten to cause rapidly spreading global pandemics like those that can be caused by influenza.

[14]The bacteria that cause cholera thrive in fresh or brackish estuarine waters and do not rely on human hosts. Yellow fever is passed among monkeys, mosquitoes, and humans. According to WHO, studies have shown that in some parts of the world monkeys may also become infected with dengue, and may serve as a source of virus for uninfected mosquitoes.

[15]Many countries, especially in Africa, prefer to administer the vaccine on an emergency basis when yellow fever outbreaks are identified.

[16]Cholera vaccines are infrequently employed because they are less than 100 percent effective and provide protection only for limited periods of time.

Global surveillance for yellow fever is quite limited. Efforts by WHO, UNICEF, and others to encourage greater investment in controlling this disease, including more widespread employment of yellow fever vaccines, have met with limited success. Ongoing laboratory training organized by WHO for the polio laboratory network in Africa has been expanded to include yellow fever but the global community has not established any specific targets for yellow fever reduction. According to WHO, countries that report information on yellow fever immunization coverage typically reach 50 percent or less of eligible children. Despite the fact that the International Health Regulations require reporting on yellow fever, WHO officials estimate that actual caseloads are up to 500 times greater than reported.

Surveillance for cholera is also problematic. While WHO and multiple partner organizations established a Global Task Force on Cholera Control in 1991, the task force was not given specific targets. Seven years later, a U.N. review found that the global community's approach focused on outbreak response and that, while this approach can reduce cholera death rates, it failed to prevent cholera from occurring.[17] Developing countries have had little incentive to improve surveillance beyond the detection of outbreaks. Although the International Health Regulations require reporting on cholera, a WHO official estimated that the numbers of cholera cases and deaths occurring in the world are 10 times higher than official reports indicate. In 1999, WHO was officially notified of approximately 9,200 cholera deaths, but disease experts believe that the annual number of deaths from cholera is closer to 120,000.

Surveillance for dengue is similarly limited. WHO developed a Global Strategy for Prevention and Control of Dengue Fever and Dengue Hemorrhagic Fever in 1995 and has, with USAID support, held two international meetings to focus attention on this disease. In collaboration with the French National Institute for Medical Research and Health and other partners, WHO has also created "DengueNet," an Internet site dedicated to gathering and sharing dengue-related information. However, without the incentive that would be provided by a clear, goal-directed international commitment to responding to the threat posed by this disease, surveillance for dengue remains limited. For example, although

[17] *See Preventive Action and Intensification of the Struggle Against Malaria and Diarrheal Diseases, in Particular Cholera*, Report by the Secretary General to the Economic and Social Council, E/1998/20.

WHO officials pointed out that progress has been made in the Americas, no organized surveillance for dengue exists in Africa, even though disease experts are certain that the illness is present there. Countries use different definitions of what constitutes a reportable case of dengue and different procedures for deciding when to report cases (that is, with or without laboratory confirmation) and for reporting on dengue versus dengue hemorrhagic fever. WHO officials highlighted the general inadequacy of laboratory support for dengue surveillance and observed that epidemiological data on dengue is "frequently incomplete, delayed, and not used for decisionmaking purposes."[18] While national authorities are officially reporting just over 1 million cases per year, WHO estimates the actual number of cases at more than 50 million per year.

In addition, public health experts observe that global surveillance for identifying and investigating emerging infections is weak. Sizable, apparently sudden outbreaks of unknown diseases, such as the 1976 Ebola outbreak in Zaire, often occur after the disease has been infecting local populations for weeks or months. Health authorities are frequently unaware of the problem until sick people begin showing up at hospitals, where concentration of infected individuals and reuse of unsterile equipment can dramatically increase the spread of the disease. Isolated cases or small clusters of cases of such diseases can be easily missed, and diseases that closely resemble others may spread before they are detected and identified. Disease experts believe, for example, that HIV/AIDS began to appear in humans decades before WHO called for its worldwide surveillance in 1981. However, these early cases were isolated and those contracting the disease tended to die from other infections, which forestalled identification and investigation of the disease. Similarly, isolated Ebola cases may have been occurring for many years, only to be diagnosed as shigella or other diseases.

[18]See *Strengthening Implementation of the Global Strategy for Dengue Fever/Dengue Hemorrhagic Fever Prevention and Control*, *Report of the Informal Consultation*, Oct. 18-20, 1999 (WHO/CDS/(DEN)/IC/2000.1).

Global Framework's Performance Constrained by Weaknesses in Developing Countries

Developing country systems are a weak link in the global surveillance framework. Surveillance systems in industrialized and developing countries suffer from a number of common constraints, including a lack of human and material resources, weak infrastructure, poor coordination, and uncertain linkages between surveillance and response.[19] However, these constraints are more pronounced in developing countries, which bear the greatest burden of disease and are where new pathogens are more likely to emerge, old ones to reemerge, and drug-resistant strains to propagate. Weaknesses in these countries thus substantially impair global capacity to understand, detect, and respond to infectious disease threats.

Surveillance Systems Lack Qualified People and Equipment

Several disease experts we met with observed that health care systems typically emphasize the care and treatment of sick people and that support systems such as surveillance are generally assigned a lower priority and receive comparatively few human and material resources. A 2000 report by the National Intelligence Council[20] concluded that, with some exceptions, such as Thailand and South Africa, developing country governments throughout Africa and Asia assigned health care a comparatively or extremely low priority. The report observed that, as a result, these countries have rudimentary or no domestic systems for disease surveillance, response, or prevention. As shown in table 1, both overall health care spending and government health expenditures tend to decline along with national income levels. For example, total health care spending per capita in low income countries amounts to about 3 percent of per capita spending in high income countries. With the fewest resources to call upon and intense pressure to provide care and treatment services, public health authorities in the poorest countries are likely to spend the least amount of resources on surveillance.

[19]For perspectives on difficulties in the United States, see *Emerging Infectious Diseases: Consensus on Needed Laboratory Capacity Could Strengthen Surveillance* (GAO/HEHS-99-62, Feb. 5, 1999); and *Emerging Infectious Diseases: National Surveillance System Could be Strengthened* (GAO/T-HEHS-99-62, Feb. 25, 1999). For perspectives on surveillance in Canada, see *Report of the Auditor General of Canada—September 1999*, "Chapter 14: National Health Surveillance: Diseases and Injuries."

[20]*The Global Infectious Disease Threat and Its Implications for the United States*, No. NIE-99-17 of the National Intelligence Estimates, National Intelligence Council (Washington, D.C.: Jan. 2000).

Table 1: Health Expenditures by National Income Level

Country category	Government expenditures on health as percentage of gross domestic product[a]	Total expenditures on health as percentage of gross domestic product[a]	Total annual health expenditures per capita[a] in international dollars[b]
High income	6.0	9.7	2,587
Upper-middle income	3.4	6.2	549
Lower-middle income	2.3	4.7	190
Low income	1.2	4.5	74

Source: Data from 2001 World Development Indicators (The World Bank, Washington, D.C., 2001).

[a]These numbers represent the most recent annual figures available from the period 1990 through1998.

[b]The term "international dollars" means that data on expenditures at the official dollar-exchange rate have been adjusted to reflect real differences in relative prices, using price surveys conducted by the United Nations' International Comparison Program.

The human resources necessary to perform surveillance activities are at a premium in developing countries. In the United States, surveillance officials at the state level report that inadequate staffing and training hinder their ability to operate. In developing countries, human resources are an even more pressing concern. Many African officials with whom we spoke said that poor salaries and working conditions drive many qualified public health workers abroad in search of work. One CDC official observed that, in Zimbabwe, only two people are devoted to surveillance at the national level.

Key positions in developing countries, including laboratory technicians and health care workers, are often filled by people who do not possess the necessary qualifications. In Uganda, for example, officials charged with assessing the national surveillance system found that a shortage of trained health care workers at peripheral health units contributed to inadequate analysis and application of data for decisionmaking, incomplete and untimely reports sent to higher levels, and a lack of laboratory confirmation or accurately validated diagnoses. WHO officials stated that laboratory personnel in developing countries often cannot competently test blood samples for malaria because they are not properly trained. WHO also observed that, although quality assurance programs are an important means of ensuring laboratory competence, staff in more than 90 percent of developing country laboratories are not familiar with quality control or quality assurance principles. Few surveillance workers in developing countries possess the epidemiological skills that make CDC so effective at

clarifying and resolving infectious disease challenges. For example, one WHO official commented that many of those assigned responsibility for analyzing disease information in developing countries are able to produce accurate tables and graphs but cannot probe the data to identify discrepancies that bear investigation.

Equipment shortages also constrain surveillance. In the United States, public health departments often lack computers and fax machines or integrated data systems that allow surveillance data to be immediately shared with public and private partners. Developing country health departments have little access to such equipment. The ability of developing country health officials to provide accurate disease information is further compromised by their frequent lack of clear and accurate diagnostic tests that they can perform themselves or ready access to functioning laboratories. As a result, they have difficulty making appropriate decisions about disease control measures and may waste valuable resources, such as antibiotics and vaccines. Inexpensive, rapid diagnostic tests are available for some diseases, including hepatitis B and HIV, but many other diseases, including cholera and yellow fever, can only be confirmed by a laboratory. CDC and WHO officials observed that public health laboratories in Africa are generally poorly funded, understaffed, and underequipped. According to WHO, more than 60 percent of laboratory equipment in developing countries is outdated or not functioning. Sixteen of the 19 WHO-sponsored assessments of African national surveillance systems that we reviewed reported weaknesses in laboratory capacity, ranging from a lack of trained technicians to deteriorating buildings, and 9 specifically cited a lack of laboratory equipment or poorly maintained equipment as reasons for difficulty in confirming cases. During fieldwork in Malawi, for example, we were told that all clinics should have a microscope to scan blood for malaria parasites, but at the clinic we visited, the only microscope was broken.

Weak Infrastructure Exacerbates Surveillance Difficulties in Developing Countries

Weaknesses in transportation and communications infrastructure in developing countries substantially impair surveillance in these countries. Many people in developing countries live in remote areas that are not served by organized health care facilities. Several national surveillance system assessments we reviewed specifically cited this as a problem or identified large portions of their populations as not having access to health care. In Uganda, for example, less than half the population lives within a 3-mile walk of a health facility.

Many cases of disease thus go unrecorded. As an epidemiologist with the Armed Forces Medical Intelligence Center commented, because the effective reach of the formal health care systems in most developing countries extends to so little of the population, patients seen at clinics represent merely the "the tip of the iceberg" in terms of disease trends and events. For example, research conducted by the Tanzanian health ministry found that, from 1992 through 1995, 46 percent of all deaths in one district occurred without prior contact with a health facility and 90 percent of all children under age 5 with high fever and seizures—a key symptom of malaria—died at home. Because local health authorities had not previously had a full understanding of disease burdens in their district, they had not chosen to focus on malaria as a top priority. However, according to national officials, the local authorities made malaria a high priority and quintupled the share of resources dedicated to controlling this disease after they learned of the data generated by this research project.

Poor roads and communications in many developing countries make it difficult for health care workers to alert higher authorities about outbreaks or quickly transport specimens to laboratories. At least 10 of the 19 assessments of African national surveillance systems that we reviewed found that less than 50 percent of the local health facilities surveyed had either telephones (or other means of communication) or vehicles for transport.[21] Even in facilities that had these resources, performance was hampered by breakdowns and insufficient funds for fuel. One clinic official in Tanzania, who did not have access to a vehicle or telecommunications equipment, informed us that in the event of an emergency, such as the need to report a suspected case of polio or cholera, he hitches a ride on one of the trucks that occasionally pass through his village. He observed that this was a workable alternative for him because his clinic was only about an hour's drive from the district health office but that his colleagues operated clinics much further away from district headquarters. These obstacles also affect the ability of higher-level officials to give feedback to the health care workers they supervise on the quality of the data being collected. Such feedback, according to public health experts, is critical to motivating health workers to continue investing time and energy in surveillance activities.

[21]This is a conservative figure because the assessments do not indicate if some or all of the sites with telephones also had radio call boxes, or if some or all of the sites with cars also had motorbikes, bicycles, etc.

Surveillance Activities Are Poorly Coordinated

Global disease surveillance is also constrained by poor coordination of surveillance activities. Multiple reporting systems, unclear lines of authority in the event of an outbreak, poor integration of laboratories into public health systems, and nonparticipation among private health care providers have combined to further hamper surveillance efforts. While these problems exist in industrialized countries, they are particularly severe in the developing world.

The disease-specific focus of control efforts has resulted in the creation of multiple surveillance systems at the national and global levels. The WHO-sponsored assessments of surveillance systems in sub-Saharan Africa found that many countries maintained at least five separate surveillance systems and that two countries had as many as nine systems. For example, in addition to maintaining separate routine surveillance systems for multiple diseases within the country and at the border, Madagascar maintains surveillance systems to support independent programs to control malaria; tuberculosis and leprosy; HIV/AIDS and other sexually transmitted diseases; plague, schistosomiasis, and cysticercosis; and diseases targeted by the Expanded Program on Immunization. While industrialized countries have more resources and expertise to cope with the resulting duplication of effort, multiple reporting systems tax developing countries' weak public health systems. As we observed during our fieldwork in Africa and our review of the 19 WHO-sponsored assessments, overburdened individuals at the lowest levels of the health system are frequently required to do everything from caring for patients to filling out reporting forms for several disease surveillance programs. These individuals may often have to choose between their responsibilities for patient care and filling out reporting forms. The accuracy, timeliness, and completeness of the disease surveillance data collected and reported may therefore be compromised. The disease-specific nature of these programs also impairs the ability of national governments to analyze overall disease trends. In Madagascar, for example, the WHO-sponsored assessment of the national surveillance system found that there was no central point for analyzing (or responding to) disease information; each of the country's multiple surveillance programs maintained its own reporting chain.

Unclear lines of authority make it difficult to know whom to contact and who is responsible for which tasks in the event of an outbreak. Such problems exist in both industrialized and developing countries. For example, a Canadian government report critiquing the national response to a 1998 salmonella outbreak in that country noted that a key local official did not know who to contact at the national level and that national officials were not sure who at their agency was responsible for handling

the issue. As a result, vital information about the scope of the outbreak was delayed.[22] Uncertainty about what to report, when, and to whom was also evident in the 1999 West Nile virus outbreak in New York City.[23] Many of the assessments of African surveillance systems that we reviewed cited weakness in this area as an important problem, as did World Bank and WHO officials.

Disease surveillance systems in developing countries do not take full advantage of nor do they coordinate the contributions that laboratories can make to surveillance. Few developing countries have public health laboratories, which means that testing to confirm outbreaks must compete with testing to support individual patient-care decisions. Laboratories and epidemiologists often report to separate sections of a nation's health ministry, resulting in poor communication between those who test disease specimens to confirm diagnoses and those who analyze disease outbreaks and trends.

Finally, private health care providers, who play an increasingly important role in many developing countries, often do not participate in surveillance programs. One health official in an urban area in Tanzania noted, for example, that her efforts to monitor local disease trends were substantially handicapped by the fact that more than 80 percent of the population in the area now seek care through private clinics. Her efforts to obtain surveillance information from these clinics had met with limited success. Another Tanzanian official working in a rural area noted that he had exerted considerable effort in building relationships with traditional healers to improve his awareness of local trends and events and had had some success, but that not all public health officials could be expected to do the same.

Uncertain Linkages Between Surveillance and Response

Surveillance is further constrained by uncertain linkages between data collection, analysis, and response. In the United States, physicians are often unaware of the need to gather information necessary for surveillance efforts and may not have had any education regarding the criteria used to launch a public health investigation. One WHO official observed that

[22] *Report of the Auditor General of Canada—September 1999*, "Chapter 15: Management of a Food-Borne Disease Outbreak."

[23] For more information, see *West Nile Virus Outbreak: Lessons for Public Health Preparedness* (GAO/HEHS-00-180, Sept. 11, 2000).

overburdened health care workers in developing countries are frequently not motivated to collect disease data because they do not see any evidence that the information is being applied or because no one has explained to them why it is valuable. A Malawi health official said that some health workers had simply thrown away the registers in which they were supposed to record data on their patients. In Zimbabwe, according to a national health official, clinic data on surges in malaria incidence often do not reach the appropriate authorities until many people have become sick or died because the clerks responsible for transmitting this information are unaware of its urgency.

The information generated by many developing country systems often does not produce a response because it is not timely or reliable enough to be useful. For example, during the 1990s, several sub-Saharan African countries introduced broadly targeted health management information systems to consolidate data collection and analysis on disease incidence and a variety of other health issues such as vaccination rates. World Bank and WHO officials commented that, while useful for other purposes, these information systems had often proven too broad in scope, cumbersome in detail, and slow to be used as effective surveillance tools. In fact, many national surveillance assessments we reviewed indicated that, despite attempts to use these systems as a means of simplifying disease reporting, they had become yet another parallel disease reporting system. Several officials with whom we spoke said that routine reporting systems often do not provide data that can be used to make long-term disease control management decisions, even though they were designed with this purpose in mind. For example, an official at the Tanzanian health ministry said that data from the country's health management information system are not reliable enough to be used for this purpose. Tanzanian government officials also observed that limitations in the routine reporting system have led them to create a separate system for gathering information on disease outbreaks through weekly telephone calls to regional-level officials within the country.

In addition, the surveillance systems that developing countries rely upon most heavily (routine reporting by health care providers) cannot, by themselves, fully inform health care decision-makers about disease trends and events. Experts at WHO, CDC, and USAID commented that supplementary efforts, such as long-term demographic surveys and analyses of vital statistics (births and deaths), can make major

contributions to understanding disease trends.[24] CDC officials stated that the recordation and use of vital statistics should be a priority for every country and that such activities should be linked to disease surveillance. However, developing countries seldom invest funds in supplementary studies[25] and often do not record vital statistics. Effective outbreak investigations also can make substantial contributions to understanding disease trends. For example, mapping the location of infected households and tracing the contacts of sick people help identify modes of transmission and risk factors. Health authorities can use this information to formulate an appropriate response to the current outbreak and forestall future outbreaks of the same illness. However, developing countries often lack the capacity to conduct thorough outbreak investigations.

Weaknesses in Developing Country Systems Impair All Facets of Global Surveillance

Weaknesses in developing country systems reduce the ability of public health authorities at every level to understand and control infectious disease threats. These shortcomings limit the success of ambitious international programs such as the polio eradication effort, and impair the routine surveillance of other diseases and the identification and control of outbreaks, newly emerging diseases, and antimicrobial resistance.

The surveillance achievements recorded by programs such as the polio eradication effort have been possible only because intensive international assistance has been given to developing countries so that they can participate in these programs. In spite of this assistance, poor surveillance in developing countries has continued to limit the ability of these programs to achieve their goals. For example, according to CDC, four countries in southern Africa were unable to meet international expectations in 1999 for detecting cases of acute flaccid paralysis, a key indicator of polio surveillance quality.[26] Seven countries in the region fell

[24]Other types of surveillance information that developing country systems do not typically generate can be used in disease control efforts. These include data on the use of drugs or other remedies that can indicate the prevalence of a disease in a given area, and on weather and drought patterns affecting populations of disease-bearing insects or animals.

[25]The Tanzania research that resulted in increased resources for controlling malaria was funded primarily by the United Kingdom's Department for International Development and the Canadian International Development Agency.

[26]Acute flaccid paralysis can be brought on by a number of causes. Even when polio is believed to have been eliminated from a country, polio officials continue to monitor surveillance systems to ensure that they report at least 1 case of acute paralysis for every 100,000 children, thus preserving the system's ability to detect cases of paralysis caused by polio.

short of the targeted 80-percent rate for collecting stool samples from suspected cases. The African region as a whole performed more poorly than any other, detecting less than the target number of potential polio cases and attaining less than the 90-percent goal for completeness of reporting. According to CDC, completing the global eradication effort is complicated by systemic weaknesses in the remaining endemic areas, which are located primarily in sub-Saharan Africa and South Asia.[27]

Ineffective routine surveillance seriously compromises the international community's ability to understand global disease burdens and trends. As already indicated with regard to yellow fever, cholera, and dengue, the global incidence of many diseases is unknown. One WHO official noted that health authorities in Equatorial Guinea, which lies within the yellow fever endemic zone of Africa, had informed him that their country has never experienced an outbreak of yellow fever. This statement cannot be disproved because no surveillance for yellow fever exists in Equatorial Guinea. Even when adequate data exist to identify gross trends, the data generally are not adequate for in-depth analyses or informed decisions about targeting resources to achieve specific control objectives.

Developing countries often cannot investigate or address outbreaks on their own. CDC's investigative expertise, including laboratory support, is comparatively rare in the rest of the world. Many of the African surveillance assessments we reviewed indicated that outbreaks there are often not thoroughly investigated, if they are investigated at all. Health officials in countries we visited and at WHO headquarters in Geneva noted that serious outbreaks strain developing countries' relatively weak public health systems, requiring them to request international assistance to cope. For example, India experienced an outbreak of plague in 1994 that resulted in hundreds of cases across the country, 56 deaths,[28] and over a billion dollars in economic damage from the travel restrictions and trade embargoes imposed by other countries. The outbreak was severe in part because India had largely discontinued surveillance for plague. Health authorities did not respond to initial complaints of flea infestation and did not take appropriate measures to contain the outbreak. The disease spread

[27]CDC also noted that armed conflict in several of these areas presents a major obstacle to completing the eradication program.

[28]This is the number reported in *Morbidity and Mortality Weekly Report* (Oct. 21, 1994), the official weekly publication of the CDC. Unofficial estimates put the death toll at several hundred.

to crowded urban slums where it progressed unchecked to its highly contagious, pneumonic form and became a serious national problem.

Shortcomings in developing country systems also limit the global community's ability to identify and effectively control newly emerging and reemerging diseases. Several factors combine to make the emergence of new pathogens more likely in developing countries. These include accelerating urbanization and overcrowding without benefit of adequate water supply and sewage systems, population displacement due to civil wars and other disasters, and increased human incursion into ecosystems where contact with pathogens that previously affected only animals or insects is more likely to occur. Developing countries are poorly equipped to conduct surveillance for such pathogens. For example, during the 1980s a bacteria long recognized as a cause of routine eye infections evolved into a pathogen capable of causing an extremely serious disease—Brazilian Purpuric Fever.[29] Since its first appearance, cases of this disease have been documented in Brazil and Australia. Experts observe that other cases may have occurred, only to be misdiagnosed as meningococcal disease. According to experts at the State University of New York at Buffalo and CDC, outbreaks of Brazilian Purpuric Fever appear to have waned. However, no organized surveillance exists for this disease, and its actual global distribution is unknown. In Uganda, local health professionals at the scene of the fall 2000 Ebola outbreak did not at first suspect the disease, despite the fact that Ebola outbreaks had previously occurred in two neighboring countries.

Although antimicrobial resistance problems have emerged in industrialized countries, such problems are more likely to escape immediate attention and become severe in developing countries. Impoverished developing countries are particularly ripe breeding grounds for the unchecked spread of drug-resistant strains due to their citizens' poor access to medical facilities; high rates of self-medication; economic, educational, and logistical difficulties in completing full courses of drug treatment; and limited drug oversight by governments. While disease experts generally regard global surveillance for antimicrobial resistance as

[29]All 10 children known to have contracted this disease in the first known outbreak died.

inadequate, developing countries conduct the least ambitious programs in this area. These countries' weak laboratories are a key constraint.[30]

Impact of Improvement Initiatives Remains to Be Demonstrated

The international community has recently launched a number of initiatives that may improve global surveillance. First, the international community has made unprecedented commitments to achieving specific reductions in the burdens imposed by HIV/AIDS, malaria, and tuberculosis. These diseases present complex challenges, and substantial effort will be required to create surveillance systems for these diseases that will permit these initiatives to move forward as their sponsors intend. Second, WHO and other members of the global public health community have launched a number of broader initiatives intended to strengthen global capacity for surveillance of infectious diseases as a group. The impact of both sets of initiatives remains to be seen.

Recent International Commitments to Control HIV/AIDS, Malaria, and Tuberculosis Will Require Improved Surveillance

Malaria, tuberculosis, and HIV/AIDS have continued to grow as public health threats, especially in developing countries, despite years of organized international control efforts. All three diseases have their most severe impacts in sub-Saharan Africa. Disease experts estimate that about 90 percent of malaria cases and 70 percent of HIV cases occur in sub-Saharan Africa. They believe that if current trends continue, Africa will also have more cases of tuberculosis than any other region by 2005.

These diseases share several characteristics that make surveillance and response comparatively difficult. First, they are relatively difficult to identify; laboratory confirmation is required for certainty in diagnosing all three. Malaria, in particular, is easily confused with other febrile illnesses in the absence of laboratory analysis. HIV-positive people often become sick—and die—from "opportunistic" infections. The underlying cause of the patient's illness may never be recognized. Further, humans can carry the pathogens that cause these diseases for extended periods without exhibiting overt symptoms. This is particularly problematic for HIV-

[30]For more information on the complex challenges that must be faced in conducting surveillance for antimicrobial resistance, see *Antimicrobial Resistance: Data to Assess Public Health Threat From Resistant Bacteria Are Limited* (GAO/HEHS/NSIAD/RCED-99-132, Apr. 28, 1999); *Containing Antimicrobial Resistance*, WHO/CDC/CSR/DRS/99.2, WHO, Geneva; and *A Public Health Action Plan to Combat Antimicrobial Resistance*, U.S. Interagency Task Force on Antimicrobial Resistance, June 2001.

positive persons, who can infect others despite their apparent lack of disease.

Second, none of these three diseases elicits a clear and effective response from the human immune system. These immunological complexities have hampered the development of easily applied, effective, and comparatively inexpensive diagnostic tools, preventive measures, or treatments that would simplify surveillance and encourage commitment to control efforts.[31] Vaccines that could effectively prevent these diseases have not yet been developed.[32] Extended multidrug medication regimens are required to cure active tuberculosis, and retard the development of AIDS symptoms in HIV-positive patients. In the case of tuberculosis these regimens take months to complete while, in the case of HIV patients, they must be followed for the life of the patient. In the case of malaria, the limited ability of the human body to develop effective immunity means that persons living in endemic areas may become sick with this disease on repeated occasions throughout their lives and must therefore be treated repeatedly.[33]

Notwithstanding these difficulties, the international community has, over the last few years, moved to adopt specific objectives for controlling these three diseases. In 1998, several organizations, including WHO, other U.N. organizations, and the World Bank, inaugurated campaigns to "Roll Back Malaria" and "Stop TB." Since that time, effective advocacy by many parties has increased support for these initiatives and for international

[31]The diseases occur in different forms within the body, presenting multiple challenges to the immune system. For example, the HIV virus evolves at such a high rate that HIV-positive patients often carry multiple strains. The malaria parasite passes through several life stages within the human body, each of which elicits a different reaction from the body's immune system.

[32]Research is proceeding to develop vaccines against malaria and HIV/AIDS and to provide an improved antituberculosis vaccine. The available vaccine against tuberculosis has been effective in preventing the disease in young children in many parts of the world. However, according to the National Institutes of Health, the vaccine has shown highly variable efficacy in preventing tuberculosis in adults and has not been effective in controlling the disease in most countries of the Southern Hemisphere.

[33] In areas where there is continuous transmission of malaria (e.g., no break during a dry season), most people who survive initial infection during childhood continue to have asymptomatic reinfections throughout their lives.

collaboration to combat HIV/AIDS. In July 2000, at the G8[34] summit in Okinawa, leaders of the major industrialized countries pledged to work toward achieving the following goals by 2010:

- Under "Roll Back Malaria," to reduce global burdens of malaria by 50 percent;
- Under "Stop TB," to reduce tuberculosis deaths and prevalence by 50 percent;
- As proposed by the U.N. Secretary General, to reduce the number of HIV/AIDS-infected young people (15 to 24 years old) by 25 percent.[35]

In commenting on a draft of this report, the Department of Health and Human Services and the Department of State pointed out that at the July, 2001 G8 summit in Italy, the industrialized countries pledged to provide at least $1.3 billion to support a new Global AIDS and Health Fund that would provide support for achieving these objectives.

Public health experts observed that substantial improvements are needed to create the surveillance support necessary to achieve these and other targets.[36] Since baseline estimates of the incidence of these diseases are subject to wide margins of error, the initiatives do not have a firm starting point from which to measure progress. For example, WHO estimates of the global incidence of tuberculosis are based on the work of a panel of disease experts that the organization called upon to analyze available data from 1997. The panel observed that the number of new cases occurring could have been as much as 21 percent lower or 40 percent higher than estimated.[37] Malaria experts observe that, because of the large margin of error in estimates of malaria incidence—which range from 300 million to

[34]The Group of Eight consists of the heads of state of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States. The President of the European Commission also participates in G8 deliberations.

[35]The U.N. General Assembly had previously expressed support for this goal (see "Report of the Ad Hoc Committee of the Whole of the Twenty-First Special Session of the General Assembly," A/S-21/5/Add.1, July 1999), and reaffirmed its support in a "Declaration of Commitment on HIV-AIDS" on June 27, 2001. The World Health Assembly has also supported an intensified effort against HIV/AIDS. See "Scaling up the Response to HIV/AIDS," World Health Assembly Resolution 54.10, May 2001.

[36]Other targets include a plan developed by WHO, UNICEF, and CDC to reduce measles deaths by 50 percent by 2005.

[37]See "Global Burden of Tuberculosis," *The Journal of the American Medical Association*, Vol. 282 (Aug. 18, 1999).

500 million cases—and the fact that many malaria cases and deaths are never diagnosed or reported, the Roll Back Malaria campaign also does not have a reliable baseline. HIV/AIDS data are similarly limited. For example, because AIDS typically appears in HIV-positive individuals years after they have been infected, HIV/AIDS surveillance systems commonly rely not only on surveillance for AIDS but on the administration of blood tests to specific populations, such as pregnant women, to provide information on HIV infection rates. However, according to the Joint United Nations Programme on HIV/AIDS and WHO, more than 40 percent of these national "sero-surveillance" systems, especially those in Africa, are of poor quality or completely nonfunctional.

Surveillance shortcomings also make it difficult to implement control programs. For example, developing country surveillance systems often cannot identify people who need treatment for these diseases. WHO estimates that, in 1999, the 23 countries with the highest burden of tuberculosis successfully detected only about 44 percent of the active cases in their countries. WHO experts also commented that laboratories in developing countries frequently cannot be relied upon to provide accurate diagnostic tests for malaria. The WHO-sponsored assessment of Uganda's surveillance system found that almost half of local health facilities could not accurately diagnose this disease. All three diseases tend to be unevenly distributed by region and population group, thus requiring improved surveillance to effectively target control efforts. HIV/AIDS experts, in particular, commented that more surveillance will be required to understand the character of HIV infection patterns and how they vary among disparate populations, including high-risk groups such as sex workers and their clients. HIV experts also observed that more surveillance information is needed on behaviors such as condom use so that effective strategies for limiting HIV transmission can be prepared.[38]

Because all three diseases have demonstrated a capacity for developing resistance to drugs, surveillance for antimicrobial resistance is also critically important. In fact, the international effort to eradicate malaria was abandoned in the late 1960s when it became apparent that both the malaria parasites and the mosquitoes that carry them were becoming resistant to the chemicals used for their control. WHO and the International Union Against Tuberculosis and Lung Disease, with support

[38]See *Second Generation Surveillance for HIV: The Next Decade*, WHO/CDS/CSR/EDC/2000.5-UNAIDS/00.03E.

from other organizations, launched a Global Project to monitor Anti-Tuberculosis Drug Resistance in 1994. Under this project, a global laboratory network was created, with internationally recognized laboratories providing support (including quality assurance testing) for lower-capacity facilities. This project has produced information on the magnitude of the threat posed by resistant strains of tuberculosis. However, the most recent report on the project's results includes data from geographic areas that include only about 28 percent of the reported tuberculosis cases in the world and two-thirds of the 23 high-burden countries targeted by the Stop TB campaign.[39] A WHO tuberculosis expert commented that he would like to see the project's geographic reach extended. Surveillance for antimicrobial resistance in malaria and AIDS patients is less organized. One malaria expert observed that data on resistance to malaria drugs are scarce, often outdated, and collected in ways that make data comparison and analysis difficult.

WHO and CDC officials observed that developing country public health systems need substantial strengthening in multiple areas to permit them to participate effectively in ambitious campaigns such as Roll Back Malaria and Stop TB. These officials observed that programs that are developed to support the new disease-specific commitments should therefore be broadly targeted. Such broadly targeted efforts could facilitate across-the-board improvements in surveillance for all infectious diseases.

Broader Initiatives Aimed at Strengthening Global Surveillance

The international community has introduced a number of initiatives to strengthen overall global capacity for surveillance of infectious diseases as a group. These include efforts to (1) strengthen global outbreak management, (2) strengthen surveillance capacity within developing countries, and (3) improve surveillance coordination and cooperation at national and regional levels. While available evidence suggests that these initiatives have merit, they are still in their early stages.

Strengthening Global Outbreak Management

Prior to the mid-1990s, the international public health community's approach to identifying and responding to major disease outbreaks was ad hoc in nature, resulting in poor responses to several significant outbreaks, including the 1994 plague epidemic in India and the 1995 Ebola outbreak in Zaire. WHO has since established a system for verifying outbreak

[39] *Anti-Tuberculosis Drug Resistance in the World, Report No. 2: Prevalence and Trends* (Geneva, Switzerland: WHO, 2000).

reports, inaugurated a network to organize and coordinate outbreak responses, and is coordinating a process to revise the International Health Regulations to provide a firmer foundation for international collaboration in identifying and responding to threatening outbreaks.

WHO launched an outbreak verification process in 1997 to help identify significant disease outbreaks around the world. This process involves collecting and verifying outbreak reports with national health authorities and others, assessing their significance, and disseminating information. To further this effort, WHO worked with the Canadian government to develop the Global Public Health Intelligence Network, an electronic surveillance system that scans the Internet for reports of infectious disease in news sources, Internet discussion groups, biomedical journals, and elsewhere. WHO officials stated that they do not receive prompt information about every important outbreak because some countries control that information, and the Network only searches the Internet in a few languages.[40] Given that outbreak reports vary in quality, WHO tries to verify reports to ensure that they present issues of potential international importance before calling attention to them. WHO generally focuses on outbreak reports from developing countries, where public health systems are weaker and more likely to require outside assistance. During the verification process, WHO may offer technical assistance, supplies, transport of specimens, or training on control measures, or help organize vaccination programs. Between November 1999 and October 2000, WHO investigated 228 outbreak reports, eventually confirming 169 significant outbreaks. The vast majority of these outbreaks occurred in developing countries; more than 40 percent occurred in sub-Saharan Africa.

In April 2000, WHO inaugurated the Global Outbreak Alert and Response Network to help organize and coordinate international outbreak response.[41] Various organizations have volunteered to participate, including national public health institutions such as CDC, as well as U.N.

[40]As of November 2000, searches were done in English and French and plans to use Spanish were under way.

[41]The World Health Assembly officially endorsed this effort in its Resolution 54.14, adopted May 2001, entitled "Global Health Security: Epidemic Alert and Response." In commenting on a draft of this report, WHO stated that its effort to develop a coordinated outbreak response system, as well as affiliated efforts to improve laboratory and epidemiological capacity in developing countries and obtain agreement on revisions to the International Health Regulations, are now being managed as an overall "Global Health Security" initiative.

and nongovernmental organizations. While Network procedures for rapidly mobilizing technical and financial support and for governing response teams are still being finalized, WHO officials believe that their efforts have improved international outbreak coordination and response. There is now a central source of verified information on outbreaks, and rapid response teams have been deployed to countries that need assistance in investigating and controlling outbreaks. For example, WHO reported that its request for assistance in an investigation of an apparent acute hemorrhagic fever outbreak in Afghanistan in June 2000 produced offers from five institutions within 12 hours and the placement of a team in-country within a week of the outbreak being verified. A major test of Network operations occurred during the Ebola hemorrhagic fever outbreak in Uganda in the fall of 2000. At the request of the Ugandan government, WHO coordinated the international response, which included more than 20 Network partners. While this system can provide effective assistance when requested by countries experiencing outbreaks, the Network partners cannot require countries experiencing outbreaks to request assistance or to take recommended measures.

In 1995, WHO initiated an effort to revise the International Health Regulations to create a firmer legal footing and a stronger institutional commitment to outbreak surveillance and response. WHO plans to have a draft revision ready for international review in late 2002, to be followed by World Health Assembly approval and acceptance by individual countries. Full implementation is projected for 2005. In launching this initiative, WHO officials noted that, for several reasons, the existing regulations' disease reporting requirements (for cholera, plague, and yellow fever) have been widely ignored. Among other things, the regulations provide little incentive for reporting. Although WHO often organizes international assistance to help countries investigate or control significant outbreaks, the regulations do not commit WHO or the international community to provide such assistance. In addition, the regulations do not protect reporting countries against trade and travel restrictions that national governments may impose against countries affected by serious disease outbreaks. While such restrictions may be justified in some cases, disease experts have found that the restrictions are sometimes excessive. For example, in 1998, the European Commission banned imports of fresh fish from four countries in East Africa during a cholera epidemic despite WHO and U.N. Food and Agriculture Organization statements that the fish posed no health risk if cooked, dried, or canned properly. Although the two organizations advised the Commission that trade restrictions were not necessary or effective in protecting consumers, the ban continued for 6 months.

Key changes to the International Health Regulations would include the following:

- Redefining reporting requirements to replace the focus on identifying all occurrences of a few specific diseases (no matter how minor) with a new focus on identifying all "events of urgent international health importance" (i.e. outbreaks of any disease that may impose adverse consequences on other countries).
- Authorizing WHO to define a range of acceptable protective measures that may be employed by countries in response to outbreaks. This provision is directed at providing reporting governments with some assurance that they will not be harmed by unreasonable trade sanctions.[42] For example, WHO would provide guidance as to whether goods entering a country from an area experiencing an outbreak should be inspected, treated, destroyed, or refused entry.
- Obligating WHO—and by extension, the international community—to respond to outbreak reports by helping reporting countries assess and control outbreaks that may have adverse impacts beyond their borders.
- Defining a set of core requirements for countries in carrying out surveillance, notification, and response.

In commenting on a draft of this report, the Department of Health and Human Services stated that the proposed revisions offer an important channel for pursuing improvements in global surveillance; but the department added that many countries will need assistance to achieve basic surveillance, notification, and response capabilities. WHO added that the revision exercise has recently gained impetus through endorsement from the World Health Assembly in its spring 2001 session[43] and that the number of countries actively involved in the negotiations has increased.

Initiatives to Strengthen Surveillance Capacity in Developing Countries

WHO, CDC, USAID, other foreign assistance agencies, and developing country governments are collaborating in a number of efforts to improve developing country surveillance and response capacity. These include

[42]Binding measures would have more of an impact in limiting trade sanctions. However, WHO and World Trade Organization experts agreed that national governments would be reluctant to accept in advance such restrictions on their ability to protect themselves under emergency conditions.

[43] World Health Assembly Resolution 54.14 included an expression of support for the ongoing revision effort and called on member countries to designate focal points for the negotiations.

efforts to improve laboratory and epidemiological capacity and to increase disease-mapping capability.

Upgrading Laboratory Capacity

While the global health community has focused on creating laboratory systems that can provide reliable support for high-priority efforts such as polio eradication and influenza control, comparatively less effort has been devoted to broader laboratory improvements. Well-functioning laboratory systems need trained personnel, adequate facilities and equipment, quality assurance programs to ensure accurate test results, and participation from laboratories with greater levels of expertise to answer complex or unusual questions.

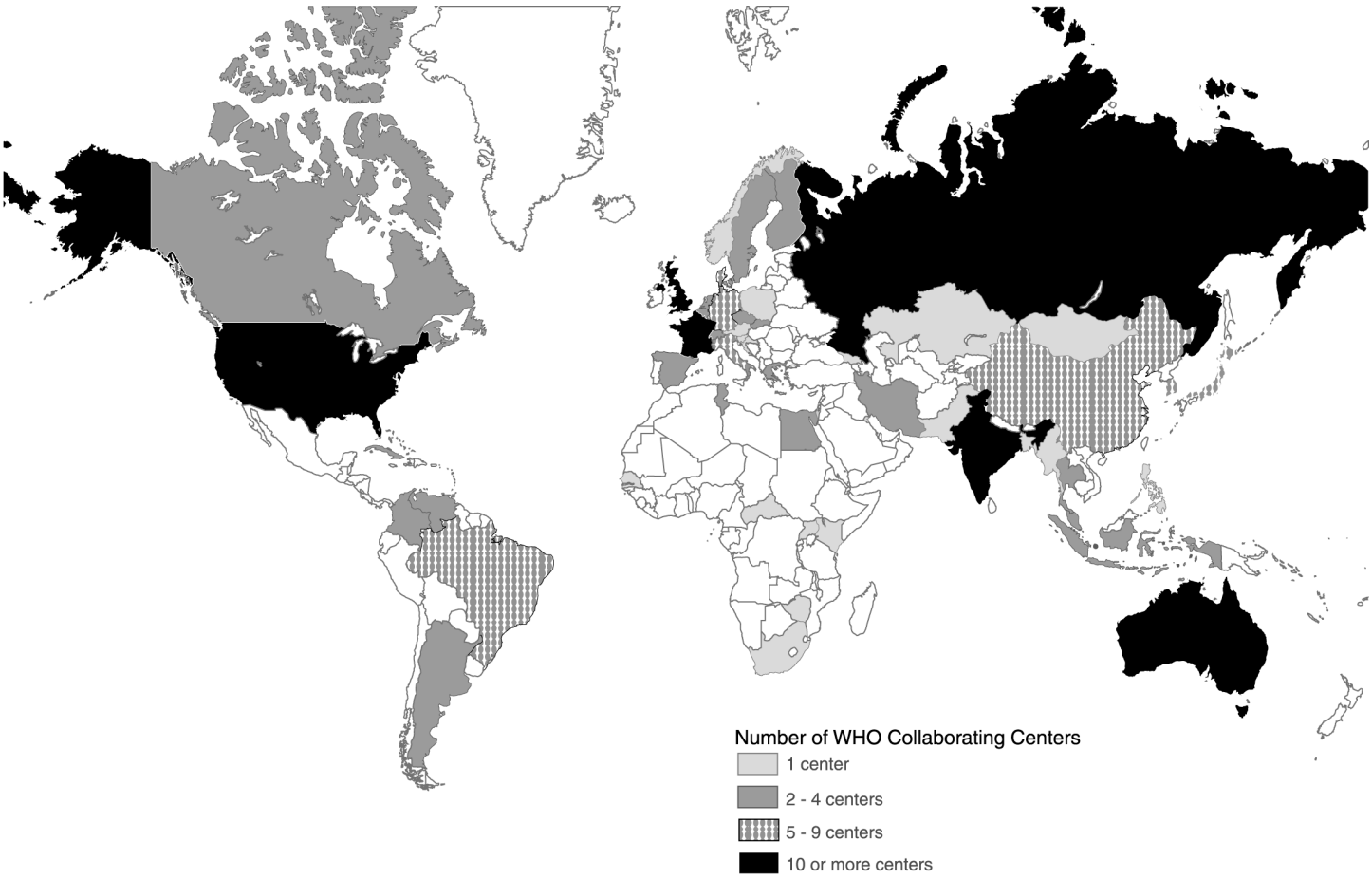
WHO coordinates several broadly targeted training and quality assurance programs designed to strengthen national public health laboratories, make cost-effective laboratory technology available, and develop and refine laboratory standards and reference materials. For example, WHO has organized voluntary quality assessment programs to monitor and improve the quality of laboratory performance in areas such as hematology and bacteriology. These programs, administered by various prominent disease laboratories around the world, periodically send out samples for participating national laboratories to examine and identify. The testing results are scored and feedback is provided to participating laboratories. While the programs involve about 450 laboratories around the world, they do not reach all countries or all laboratories. Further, they are not fully funded by WHO, and the various laboratories charged with operating them have had to cover most of the costs of operating these programs. Some of WHO's regional offices have also begun investing in programs to strengthen national laboratories in their regions.

In 2001, WHO, with support from the city of Lyon, the Government of France, and the Merieux Foundation, established a new program to strengthen laboratory and epidemiological capacities for handling disease outbreaks in developing countries. Intended to serve 45 developing countries over the next 5 years, the program's first phase began in April 2001, with 15 senior staff from national public health laboratories in 7 French-speaking African countries. During their 2-year course of study, participants will be expected to develop detailed plans for addressing the needs of their laboratories. Plans are for later trainees to come from the Middle East and North Africa, the Baltics and Central Asia, and possibly South Asia and additional African countries. In commenting on a draft of this report, USAID pointed out that it is working with the new program in

Lyon to develop a Quality Control/Quality Assurance Program for national laboratories in Africa.

International networking is an effective way to provide developing countries with access to more highly specialized laboratory services as well as assistance in improving the quality of their own laboratory services. Such international networks are a prominent feature of some disease-specific initiatives, including polio eradication and influenza control. WHO has created a system of Collaborating Centers, in part to ensure that developing countries can access support services when needed. WHO currently maintains a worldwide system of more than 270 Centers that focus on infectious diseases. However, as shown in figure 2, Collaborating Centers tend to be concentrated in industrialized countries. Relatively few are located in Africa, despite the high burden of infectious diseases on that continent. With 38 Collaborating Centers, CDC is the single largest contributor of expertise and resources to this system.

Figure 2: Distribution of WHO Collaborating Centers for Infectious Disease Surveillance and Control



Source: Prepared by GAO using list of Collaborating Centers provided by WHO.

In 1999, WHO issued a report that identified a number of shortcomings in the Collaborating Centers system, including a lack of consistency in the criteria for selecting centers and the absence of a systematic means for evaluating their activities. WHO found that some Collaborating Centers contribute little to international disease control efforts. WHO is amending its procedures for working with the Centers to address these shortcomings through a more rigorous and consistent designation process, joint preparation of Center work plans, closer monitoring and evaluation, and the development of a global database to meet the needs of national and international health authorities. WHO also continues to work with Collaborating Centers and other institutions to encourage the growth of

existing networks for sharing information on particular diseases and initiatives to establish additional networks.

Improving Epidemiological Capacity

International public health officials have long recognized the need to develop strong epidemiological skills in countries and institutions around the world. CDC is widely acknowledged as having the strongest institutional capabilities for investigating and resolving complex disease management challenges. Since its founding in 1951, CDC's Epidemic Intelligence Service has provided approximately 2,300 health professionals from the United States and elsewhere with the skills to investigate disease events and trends and improve surveillance systems. At the request of national governments, CDC, WHO, USAID, the Rockefeller Foundation, and the European Union have helped establish 27 additional training programs in applied epidemiology worldwide, which are modeled after CDC's Epidemic Intelligence Service. According to CDC, non-U.S. programs, about half of which are located in lower-income countries, had trained over 900 people as of January 2001.[44]

The common goals of these programs include (1) developing a cadre of national public health professionals, (2) providing essential epidemiological and public health services to the country during and after training, and (3) building regional and international linkages between countries to support public health response and training. According to public health experts, an underlying goal is to develop an information-based culture for public health decisionmaking in every country.

A CDC-sponsored evaluation of five of these programs in 1998 found that epidemiologists trained by the programs have had a positive impact on the quality of their national public health programs. For example, graduates have helped (1) improve surveillance system procedures and outbreak investigations, (2) develop local surveillance capacity, and (3) design research programs that influenced national health policy decisions. According to CDC and WHO staff, graduates of these programs made important contributions to addressing recent outbreaks of Ebola in Uganda and Rift Valley fever in Yemen and Saudi Arabia.

[44]Programs in lower income countries include those located in Colombia, Cote d'Ivoire, Egypt, Ghana, Indonesia, Jordan, Peru, the Philippines, Thailand, Uganda, Vietnam, and Zimbabwe, as well as a regional program in Central America.

Many of the disease experts we spoke with cited continued expansion of these programs as a key element in global efforts to improve surveillance capacity and performance.

However, a low mentor-student ratio is one key factor in the success of applied epidemiology training programs, and this places a limit on the speed at which such programs can be expanded. Twenty of the programs currently in existence were inaugurated within the last decade. For example, programs in Brazil and the Indian state of Tamil Nadu have just begun, while a program in China is still in the planning stages. These programs will take many years to have a significant impact.

Increasing capacity for mapping disease information

CDC, the WHO Regional Office for the Americas, and WHO headquarters (in collaboration with UNICEF) have all developed computer software to generate maps of disease conditions in specific geographic areas that can help inform decisionmaking. Over the past decade, these disease-mapping systems have had a positive effect on surveillance in developing countries, especially in supporting disease-specific initiatives. For example, the WHO/UNICEF HealthMapper application was used to support the guinea worm eradication and river blindness elimination efforts and is beginning to be used in global efforts against malaria and HIV/AIDS. Experts believe that there is great potential for employing such systems to predict disease outbreaks and trends in relation to climate and weather patterns. However, they note that such systems are constrained by the quality of available data on diseases and underlying features such as population distribution and the locations of health facilities and water supplies, as well as limited access to satellite-generated information.

Coordinating Surveillance Operations

The international community has initiated efforts to expand coordination of surveillance at the national level, especially in developing countries, and within regions. These efforts can help reduce reporting burdens and make better use of limited resources.

With assistance from CDC, WHO's Regional Office for Africa launched the Integrated Disease Surveillance and Response (IDS) initiative in 1998 to improve linkages between surveillance and response by generating more accurate, timely, relevant, and complete data. In commenting on a draft of this report, USAID added that it has also assisted in launching this initiative, making several grants to WHO's Regional Office for Africa to support relevant activities. Although the World Health Assembly has not

officially endorsed IDS, a number of countries and regions of the world are also seeking greater integration of their surveillance operations.

IDS is not intended to replace disease-specific programs. Rather, it seeks opportunities for pooling funds and personnel to improve surveillance for multiple diseases. While the long-term goal is to improve coordination among all surveillance programs, the initiative is presently directed primarily at encouraging greater cooperation in surveillance for epidemic-prone diseases such as cholera and vaccine-preventable diseases, such as measles.

Evidence suggests that the initiative may have a favorable impact. For example, according to WHO, IDS planning has enhanced coordination and support for surveillance within public health ministries in at least three African countries. CDC found that 26 African countries had already begun to employ polio eradication resources to perform surveillance for other diseases, without impairing the quality of polio surveillance. However, implementing IDS presents significant challenges and will require substantial time and effort. For example, baseline assessments of African surveillance systems began in late 1998. As of April 9, 2001, only 10 of 46 countries in WHO's Africa region had both completed assessments and developed plans for addressing weaknesses. CDC and WHO took several years to develop generic surveillance guidelines that can be used to put these plans into action. The guidelines were sent to WHO's Africa Regional Office in the summer of 2001. CDC officials observed that this slow pace reflects the inherent difficulties in creating manageable systems that satisfy multiple stakeholders. For example, IDS requires agreement on issues such as how to reduce reporting burdens by requiring routine reporting of only "essential information." However, disease-specific program managers typically have a very broad definition of the term "essential information" when it comes to diseases for which they are responsible. CDC officials also noted that the IDS negotiations have required national officials to agree on issues that they have never before addressed, such as defining threshold levels to determine what constitutes an outbreak and creating procedures for outbreak response.

Public health authorities and others are also working on creating regional surveillance networks. For example:

- The Pacific Public Health Surveillance Network was established in 1996 to improve surveillance and response among the Pacific Community's 22 member states and territories.[45] Network activities include (1) an Internet system for sharing information on disease trends and events, and (2) diagnostic and other types of assistance to isolated health care facilities. The network has begun to function as an outbreak response coordinator and is working to assemble a regional laboratory system to support timely and appropriate outbreak response.
- Countries in the Amazon basin and the "Southern Cone" of South America[46] have been working since 1998 to create laboratory networks to improve surveillance of new, emerging, and reemerging infectious diseases. Because of these efforts, participating laboratories have identified an increasing number of Hantavirus pulmonary syndrome cases, including in areas where the disease had not previously been recognized. Participating countries are emphasizing integration of epidemiologists and laboratory personnel to advance network goals.
- With CDC and Department of Defense support, several countries in Southeast Asia are working to establish a regional network to improve outbreak detection and response.

Concluding Observations

The global disease surveillance framework is dominated by networks directed at providing information on specific disease threats. The framework supplies comparatively good information when demanded by well-supported, goal-oriented disease control initiatives. Surveillance capacity for other diseases is comparatively weak, and these weaknesses are most acute in developing countries. The continued weakness of developing country surveillance systems not only impairs global surveillance operations, but necessitates the application of substantial resources to create effective global systems each time the international community identifies an additional priority disease target. It also requires institutions such as CDC to devote resources to respond to outbreaks in developing countries that exceed local authorities' capacity. To date, while facilitating the relatively rapid achievement of disease-specific results, the

[45]The members of the Community are the Cook Islands, the Federated States of Micronesia, Fiji, Guam, Kiribati, the Northern Marianas, the Marshall Islands, Nauru, Niue, New Caledonia, Palau, Papua New Guinea, Pitcairn Island, French Polynesia, the Solomon Islands, Samoa, American Samoa, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.

[46]Countries participating in the Amazon regional effort are Bolivia, Brazil, Colombia, Peru, and Venezuela. Countries participating in the Southern Cone regional effort are Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay.

creation of additional surveillance systems to serve new initiatives has left developing countries' underlying surveillance problems unresolved.

International public health officials concerned about the overall threat of infectious disease are seeking to take advantage of the global community's apparent willingness to commit itself to achieving measurable progress against three major disease threats—HIV/AIDS, tuberculosis, and malaria—to support broader systemic improvements in developing country surveillance and response capacity. These broad improvements may eventually reduce the need for disease-specific campaigns. However, given the need to demonstrate progress against these three diseases in particular, the extent to which the global public health community can manage the new disease-specific initiatives in a manner that significantly improves surveillance for all infectious disease threats, remains to be demonstrated.

USAID's and the Department of Health and Human Services' comments on a draft of this report offer additional perspectives on the challenges to be faced in developing strategies for responding to specific disease threats while also addressing overall weaknesses in surveillance capacity. USAID noted the failure of past disease-specific initiatives (like smallpox eradication) to leave a lasting positive impact on surveillance capacity in developing countries. The agency is attempting to insure that its ongoing polio-eradication activities advance the eradication program while also upgrading developing countries' capacity for monitoring and responding to other diseases. USAID also observed that many of the weaknesses in developing country systems documented in this report require donor attention outside the range of disease specific programs. The Department of Health and Human Services observed that while expanded efforts to improve surveillance and response capacity for HIV/AIDS, malaria, and tuberculosis are clearly warranted, other significant infectious disease threats also need attention. The department concluded that both disease-specific and cross-cutting programs are needed, and that these programs can and should be carried forward in ways that are mutually supportive.

Agency Comments and Our Evaluation

We received written comments on a draft of this report from the Department of Health and Human Services, the Department of Defense, WHO, USAID, the National Aeronautics and Space Administration, and the World Bank. The World Bank's letter was transmitted through the Department of the Treasury. These comments are reprinted in appendixes III through VIII, along with our evaluations, where appropriate. The Department of State provided oral comments. In addition, WHO's

Department of Communicable Disease Surveillance and Response and CDC provided technical comments, which we have incorporated where appropriate.

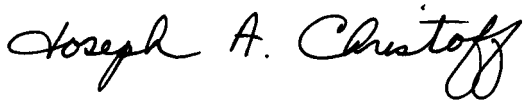
In general, the agencies concurred with the report's findings. The Department of Health and Human Services commented that the report presents an accurate and thorough evaluation of global infectious disease surveillance. In their oral comments, officials from the State Department's Bureaus for International Organization Affairs and Oceans and International Environmental and Scientific Affairs stated that the report accurately portrayed the issues and obstacles that the international community faces in dealing with infectious disease surveillance. The Department of Health and Human Services and USAID elaborated upon the reports' concluding observations concerning the challenges to be faced in pursuing both disease-specific and more-broadly focused improvements in surveillance capacity. We expanded our concluding observations to reflect these comments.

USAID, the Department of Defense and, to a lesser extent, the World Bank, WHO, and the Department of Health and Human Services provided additional information on their contributions to building global surveillance capacity. USAID and the Department of Defense, in particular, said that the draft report did not adequately describe their efforts to improve global surveillance. USAID highlighted its efforts to assist developing countries in developing surveillance capacity outside the bounds of disease-specific initiatives. The Department of Defense cited relevant activities being undertaken through the Department's Global Emerging Infections Surveillance and Response System. The World Bank pointed out that as part of its emphasis on health, it is actively working with a number of governments to strengthen national surveillance system. The Department of Health and Human Services cited CDC's global strategy paper *Working with Partners to Improve Global Health: A Strategy for CDC and ATSDR*[47]—a document which provides extensive information on CDC activities that contribute to strengthening global surveillance capacity. Where appropriate, we added information on these agencies' efforts to the report. However, the report was not designed to provide a comprehensive accounting of all worldwide efforts. We refer the reader to the appendixes for additional information as provided by the agencies.

[47]The Agency for Toxic Substances and Disease Registry.

We are sending this report to interested congressional committees, the Secretary of the Treasury, the Secretary of State, the Secretary of Health and Human Services, the Secretary of Defense, the Administrator of USAID, the Administrator of the National Aeronautics and Space Administration, and the Director General of the World Health Organization. We will also make copies available to other interested parties on request.

Please contact me on (202) 512-8979 if you or your staff have any questions concerning this report. An additional GAO contact and staff acknowledgements are listed in appendix IX.



Joseph A. Christoff, Director
International Affairs and Trade

Appendix I: Objectives, Scope, and Methodology

At the request of the Chairmen and Ranking Members of the Senate Subcommittee on Foreign Operations, Committee on Appropriations, and the Senate Subcommittee on African Affairs, Committee on Foreign Relations, we evaluated the global infectious disease surveillance framework. Specifically, we (1) examined the surveillance framework's evolution and current operations, (2) identified factors that constrain its performance, and (3) assessed several initiatives designed to improve global infectious disease surveillance and response.

To determine the surveillance framework's evolution and current operations, we interviewed officials responsible for international surveillance-related activities at World Health Organization (WHO) offices, including WHO headquarters in Geneva, Switzerland; the Pan-American Health Organization (the WHO Regional Office for the Americas) in Washington, D.C.; and the Regional Office for Africa in Harare, Zimbabwe. We interviewed officials at various U.S. agencies, including the Centers for Disease Control and Prevention (CDC), the National Institutes of Health (both of which are constituent elements of the Department of Health and Human Services), the U.S. Agency for International Development (USAID), the Armed Forces Medical Intelligence Center, the Walter Reed Army Institute of Research, the National Aeronautics and Space Administration, and the White House Office of Science and Technology Policy; and at multilateral development institutions, including the World Bank. We interviewed disease experts in academia and officials at nongovernmental organizations such as the Association of Public Health Laboratories. We reviewed the International Health Regulations, as well as documents and studies from WHO and other sources pertaining to international efforts to control specific diseases and guide surveillance. We also attended conferences dealing with international infectious disease control and surveillance issues.

To identify factors that constrain the performance of the global disease surveillance framework, we interviewed the officials listed above and conducted fieldwork in four African countries—Malawi, Tanzania, Uganda, and Zimbabwe. We selected these countries from a larger group of African countries that had recently conducted assessments of their national disease surveillance systems. We limited our fieldwork to Africa because of interest expressed in this region by the requesters of this work, as well as Africa's infectious disease burden, the weak condition of most African health care systems, and the concerted efforts under way to improve surveillance in this region. While in Africa, we interviewed officials at national health ministries; multilateral agencies, including WHO country and regional offices, the World Bank, and the African

Development Bank; foreign assistance and technical agencies from the United States and other countries, including USAID and CDC; and nongovernmental organizations active in the health sector. We reviewed documentation on surveillance systems in each country and discussed these countries' experiences with recent disease outbreaks. We also visited health facilities in each country, including central and district hospitals and laboratories, research institutions, local clinics, and designated surveillance sites for specific diseases such as malaria. At each site, we observed conditions and discussed with knowledgeable officials the ways in which surveillance is conducted, the extent to which surveillance data are analyzed and used, and factors that constrain surveillance activities. In addition, we systematically reviewed the 19 assessments of surveillance systems in African countries that WHO, together with CDC and national health authorities, had completed as of April 2001. We also reviewed studies of surveillance problems in developing and industrialized countries, including the United States and Canada.

To assess initiatives designed to improve global infectious disease surveillance and response, we interviewed WHO, World Bank, CDC, USAID, and other officials to identify and discuss key initiatives currently under way to improve regional and global surveillance. When pertinent, we also asked national officials we met during our fieldwork about their involvement in these initiatives, particularly WHO's Integrated Disease Surveillance and Response effort in the Africa region. We reviewed documents describing the purpose, status, and outcomes to date (where appropriate) of these programs. For our review of WHO efforts to improve international outbreak detection and response, we collected and analyzed information from WHO on disease outbreaks that had been entered in its Outbreak Verification List database from November 1999 through October 2000, including detailed case histories of the international response to a small number of these outbreaks. We also collected and reviewed information on outbreaks from other sources—including ProMED, an Internet service of the International Society for Infectious Diseases.

We did not address specific surveillance problems that arise in countries or regions affected by armed conflict or the complex humanitarian emergencies that such conflicts often produce. As noted in our July 2000 report on surveillance, health care to populations affected by such emergencies is typically provided by international and nongovernmental organizations rather than by national governments, and these organizations face obstacles and pressures that are not faced by public health systems functioning in nonemergency conditions. Since this report

focused on the development and application of surveillance information, we did not explore the feasibility of improvements in diagnostic, preventive, or treatment technologies.

We conducted our work from July 2000 through June 2001 in accordance with generally accepted government auditing standards.

Appendix II: Disease Information

This appendix provides descriptive information on the diseases mentioned in the body of this report. The information is derived primarily from WHO and CDC documents.

Brazilian purpuric fever, first observed in 1984, is caused by an evolved form of a bacterium that causes a common eye infection, conjunctivitis. In its evolved form, this pathogen can invade the bloodstream and cause a lethal infection characterized by high fever, shock, and a severe bleeding disorder. Outbreaks of the disease have appeared to wane. The factors that caused the disease to suddenly appear and then seem to disappear have yet to be determined. According to disease experts, northern Africa and other parts of the world where the original form of the bacterium in question is common are potentially at risk for epidemics of this disease.

Chagas disease is caused by a parasite transmitted by insects, by transfusions of contaminated blood, or from mother to fetus. The acute phase of the disease often has no symptoms or an inflammation at the site of the infection and flu-like symptoms. If caught in its early stages, the parasite can be seen in the blood and the disease can be cured with drugs. After that, the parasite moves into body tissue, where it cannot be treated and can cause severe, life-threatening conditions 10 to 30 years later, including heart disease. Up to 18 million people in 18 countries in South and Central America are infected. As many as 100,000 infected people, mostly immigrants, are estimated to reside in the United States.

Cholera is caused by a water- and food-borne bacterium. Infection results in acute watery diarrhea, leading to extreme dehydration and death if not addressed. Known vaccines and antibiotics have only limited impact on the disease; treatment focuses on rehydration. According to WHO, recent cholera outbreaks have killed 3.6 percent of those who become ill worldwide. Cholera is endemic in more than 80 countries. During the 1990s, global cholera reports varied from about 100,000 to about 600,000 cases per year.

Cysticercosis is a parasitic infection caused by the pork tapeworm, whose eggs may be ingested in contaminated food and water. Inside the human body, the larvae hatch and form cysts in the organs, particularly the muscles, eyes, and brain. Although most cases are asymptomatic or mild, patients may experience vision problems, headaches, seizures, and brain swelling. The infection can be treated with drugs and sometimes surgery. The disease occurs worldwide but is found most often in rural, developing countries with poor sanitary conditions and where pigs are allowed to roam freely.

Dengue fever, a mosquito-borne infection caused by four distinct but closely related viruses, is a severe, flu-like illness with specific symptoms that vary based on the age of the victim. Dengue hemorrhagic fever is a potentially lethal complication that may include convulsions. There is no vaccine for dengue fever, nor is there any treatment beyond supportive therapy. With treatment, fatality rates can be less than 1 percent; without it, they can exceed 20 percent. Dengue is endemic in more than 100 countries.

Diphtheria is a respiratory disease caused by a virus-infected bacterium. Occurring worldwide, the disease is spread through human-to-human contact. Symptoms range from mild to severe. Diphtheria can be complicated by damage to the heart muscle or peripheral nerves. An effective vaccine is typically provided through national childhood vaccination programs. The disease is fatal 5 to 10 percent of the time, even when treated by administration of antibiotics and diphtheria antitoxin. Untreated, the fatality rate can be much higher.

Ebola hemorrhagic fever, a viral disease, is transmitted by direct contact with the body fluids of infected individuals, causing acute fever, diarrhea that can be bloody, vomiting, internal and external bleeding, and other symptoms. There is no known cure, although some measures, including rehydration, can improve the odds of survival. Ebola kills more than half of those it infects. Identified for the first time in 1976, the Ebola virus is still considered rare, but there have been a number of outbreaks in central Africa.

Guinea worm disease, formally known as dracunculiasis, is transmitted by drinking water contaminated with parasite larvae. The mature parasite travels through the body, usually emerging through the foot or leg. Perforation of the skin is accompanied by fever, extreme pain, nausea, and vomiting, and an infected person can stay ill for several months. Fatalities are rare, but secondary infection and permanent deformity can occur. There is no vaccine or drug to prevent infection or kill the worms; however, transmission of the disease can be halted through education and the provision of safe drinking water. The disease has been eradicated from several countries, but remains present in 13 African nations, according to CDC.

Hantavirus pulmonary syndrome is caused by several strains of a virus that is transmitted by exposure to infected rodents. Symptoms include fever, fatigue, muscle aches, coughing, and shortness of breath; the onset of respiratory distress often leads to death. There is no specific treatment

for the disease, other than appropriate management of respiratory problems. The virus was first identified in the southwestern United States in 1993, but several hundred cases have since been confirmed in other U.S. locations, Canada, and several countries in South America.

Hepatitis B is a viral infection of the liver that is readily transmitted by contact with the body fluids of an infected person. In many developing countries, most children become infected. The virus may cause an acute illness, as well as a life-long infection that carries a high risk of serious illness or eventual death from liver cancer or cirrhosis. An effective vaccine is available, and WHO has recommended that it be added to routine childhood immunization programs in all countries. About 2 billion people worldwide have been infected with the virus, and about 350 million people remain chronically infected.

Human immunodeficiency virus (HIV) causes acquired immunodeficiency syndrome (AIDS), a disease of the immune system. HIV is transmitted through contact with the body fluids of an infected person or from mother to baby. Infected adults may be asymptomatic for 10 years or more. Because the immune system is weakened, there is eventually greater susceptibility to opportunistic diseases such as pneumonia and tuberculosis. Drugs are available that can prevent transmission from pregnant mothers to their unborn children and can help slow the onset of AIDS. As of December 2000, an estimated 36.1 million people worldwide were living with HIV/AIDS and about 21.8 million had died.

Influenza, or flu, is a highly contagious respiratory infection caused by three types of virus, of which two (types A and B) can reach epidemic proportions and are found worldwide. Symptoms include fever, cough, sore throat, runny or stuffy nose, headache, muscle aches, and often extreme fatigue that may last 1 to 2 weeks. Severe complications such as pneumonia sometimes occur in children, the elderly, and other vulnerable populations. There is an influenza vaccine, but the viruses change so quickly that the vaccine must be updated every year. Several drugs exist to prevent and treat influenza.

Leprosy is a chronic bacterial infection. The exact mode of transmission is not fully understood. Primarily affecting the skin, nerves, and mucous membranes, leprosy causes deformities of the face and extremities after many years but can be cured with drugs. About 680,000 new cases were reported in 1999. India, Myanmar, and Nepal account for about 70 percent of all leprosy cases.

Lyme borellosis, or Lyme disease, is a bacterial illness transmitted by ticks. The pathogen was first detected in the United States in 1982 and identified as the cause of the disease. The area around the tick bite sometimes develops a "bull's eye" rash, typically accompanied by fever, headache, and musculoskeletal aches and pains. There is an effective vaccine for adults at high risk. If untreated by antibiotics, arthritis, neurologic abnormalities, and—rarely—cardiac problems follow. The disease is rarely if ever fatal and is endemic in North America and Europe.

Lymphatic filariasis is a parasitic disease transmitted by mosquitoes. The infection causes severe pathology of the lymph system resulting in elephantiasis, or gross swelling, of the limbs and genitals and organ damage. Diagnostic tools have improved, and more recently drug treatment options have replaced mosquito control as a strategy for eliminating the disease. At least 120 million people in 80 countries worldwide are infected in both rural areas and densely populated urban slums.

Malaria is a parasitic disease, transmitted by mosquitoes and endemic in 101 countries and territories. Symptoms include fever, shivering, joint pain, headache, repeated vomiting, severe anemia, convulsions, coma, and in severe cases death. Malaria is becoming increasingly resistant to known primary drug treatments. About 40 percent of the world population is considered at risk for malaria. Ninety percent of malaria cases are in sub-Saharan Africa, but the disease is now reemerging in countries where it was once under control.

Measles, a highly contagious viral disease, often strikes children and causes fever, conjunctivitis, congestion, and cough, followed by a rash. This disease is transmitted by human-to-human contact, and secondary infections often cause further complications. Sustained efforts to immunize children have reduced the prevalence of this disease, but it still occurs worldwide, with an estimated 30 million cases leading to approximately 900,000 deaths every year.

Meningitis, a condition that may be caused by several disease agents, is an infection and severe inflammation of the fluid membranes surrounding the brain and spinal cord.

Meningococcal meningitis, caused by a particular type of bacteria, is transmitted by human-to-human contact and is characterized by sudden onset of fever, headache, neck stiffness, and altered consciousness. There is a vaccine for this disease, but it loses its effectiveness over time and

must be repeated. Untreated epidemics can incur fatality rates of over 50 percent but epidemic fatality rates in the last 30 years have generally been in the 8 to 12 percent range. Epidemics of meningococcal meningitis are a frequent occurrence in Africa's "meningitis belt," which stretches from Senegal to Ethiopia. An estimated 500,000 cases and 50,000 deaths occur each year due to meningococcal meningitis.

Pertussis, or whooping cough, is a highly contagious bacterial disease spread through respiratory droplets from an infected person. Symptoms include runny nose and sneezing, a mild fever, and a cough that gradually becomes more severe, turning into paroxysms of coughing that end in vomiting and exhaustion. Pertussis is treatable with antibiotics, and the pertussis vaccine is commonly administered as part of routine childhood immunization programs. Twenty million to 40 million cases with 200,000 to 300,000 deaths are reported worldwide every year. Most occur in developing countries.

Plague, a severe bacterial infection, is usually transmitted to humans by infected rodent fleas (bubonic plague) and uncommonly by person-to-person respiratory exposure (pneumonic plague). Symptoms of bubonic plague include swollen, painful lymph glands (buboes), fever, chills, headache, and exhaustion. People with pneumonic plague develop cough, bloody sputum, and breathing difficulty. Plague is treatable with antibiotics. However, unless diagnosed and treated early, it is highly fatal. Approximately 1,000 to 4,000 cases of plague are reported each year, but these figures represent only a portion of the actual number of cases.

Poliomyelitis, or polio, is a virus transmitted through human-to-human contact. In most cases, there are no symptoms or only mild, flu-like symptoms. Five to 10 percent of cases can lead to aseptic meningitis, while only 1 percent of infections lead to the acute flaccid paralysis associated with polio. Although there is no cure, an effective vaccine is included as part of routine childhood immunizations. Fewer than 3,500 confirmed cases were reported in 2000, with transmission still occurring in up to 20 countries.

Rift Valley fever is a viral disease that primarily affects animals—including domesticated livestock—but can be transmitted to people by mosquitoes or contact with the body fluids of infected animals. Rift Valley fever usually causes a flu-like illness lasting 4 to 7 days, but about 1 percent of cases develops into a more severe hemorrhagic fever that has an approximately 50-percent fatality rate. An antiviral drug has been identified and is being tested, and vaccines are under development. The

disease has occurred in many parts of Africa and, in September 2000, was for the first time reported outside of Africa, in Saudi Arabia and Yemen.

River blindness, or onchocerciasis, is a parasitic disease. Blackflies transmit the larvae of parasitic worms to humans, where they grow into adult worms with a lifespan of 12 to 15 years. These worms spawn millions of microscopic parasites that travel throughout the body causing unbearable itching, skin disfigurement, and vision impairment or blindness. Treatment with the drug ivermectin kills the infant parasites but has very limited if any effect on adult worms. The disease is endemic in 37 countries, with nearly all cases in Africa.

Salmonella infection, or salmonellosis, is caused by a group of bacteria that may be present in contaminated foods—often raw or undercooked foods of animal origin. It causes acute diarrheal illness, for which treatment is usually not required. In some cases, however, the infection can spread in the bloodstream and cause death unless antibiotics are used. Over 2,200 strains of Salmonella bacteria have been identified, including some that have developed antibiotic resistance and are hence more difficult to control. The disease is common in both developed and developing countries.

Schistosomiasis, known in some regions as Bilharzia, is caused by five species of parasitic flatworms, called schistosomes. The flatworms, which are carried during part of their lifecycle by fresh water snails, penetrate the skin when people swim or wade in contaminated water. The flatworms grow inside the blood vessels and produce eggs that can damage the intestines, bladder, and other organs and eventually cause bladder cancer, kidney failure, or serious complications of the liver and spleen. Safe, cost-effective drugs are available to treat the disease. Schistosomiasis is endemic in more than 70 developing countries, infecting an estimated 200 million people, 20 million of whom have severe illness. Over 80 percent of the cases are found in Africa.

Shigellosis is a highly contagious, diarrheal disease caused by four strains of bacteria. One of these strains, an unusually virulent pathogen, causes large-scale, regional outbreaks of dysentery (bloody diarrhea) with mortality rates of 5 to 15 percent. Transmitted by human-to-human contact and contaminated food and water, this disease is common in crowded areas with poor sanitation and unsafe water supplies. In addition to diarrhea, patients experience fever, abdominal cramps, and rectal pain. The disease is treatable by rehydration and antibiotics, but antimicrobial

resistance has become widespread. All types of shigellosis together cause an estimated 600,000 deaths per year, mostly in developing countries.

Smallpox is a highly contagious viral disease transmitted from person to person, with a high mortality rate and a history of epidemics throughout the world. Patients experience fever, aching, and prostration, followed by a painful rash that spreads over the entire body and eventually leaves pitted scars and sometimes causes blindness. There is no effective treatment for the disease; however, the development of a vaccine enabled the worldwide eradication of smallpox by 1977. At the start of the eradication campaign in 1966, an estimated 10 million to 15 million cases occurred globally each year, resulting in more than 2 million deaths.

Tetanus, or lockjaw, is caused by a bacterium found in the intestines of many animals and in the soil. It is transmitted to humans through open wounds. Neonatal tetanus is a particular problem in newborn infants due to unsanitary birthing practices. Symptoms include generalized rigidity and convulsive spasms of the skeletal muscles. Tetanus can be treated with an antitoxin, and there is an effective vaccine, commonly included in childhood vaccination programs. It is fatal about 30 percent of the time and occurs worldwide. Neonatal tetanus causes an estimated 270,000 deaths each year, mostly in developing countries.

Tuberculosis is a bacterial disease that is usually transmitted by contact with an infected person. People with healthy immune systems can become infected but not fall ill—more than one-third of the world's population is thought to be infected. Symptoms of tuberculosis can include a bad cough, coughing up blood, pain in the chest, fatigue, weight loss, fever, and chills. Several drugs can be used to treat tuberculosis, but the disease is becoming increasingly drug resistant. The available vaccine, commonly administered to children, has a limited effect. The disease is estimated to kill 2 million people each year.

West Nile fever is a mosquito-borne viral disease. Symptoms include fever, head and body aches, rash, and, in more serious cases, stupor, coma, convulsions, and paralysis. Death occurs in 3 to 15 percent of cases. There is no vaccine for the West Nile virus, and no specific treatment besides supportive therapies. The disease occurs in Africa, Eastern Europe, West Asia, the Middle East, and, since 1999, the United States.

Yellow fever is a mosquito-borne viral disease whose symptoms include fever, muscle pain, headache, loss of appetite, and nausea. Fifteen percent of patients progress to a toxic phase, which can include jaundice, abdominal pain, and bleeding from the mouth, nose, eyes, or stomach. The kidneys deteriorate and may fail. Half of patients who enter this phase die. There is no treatment for yellow fever beyond supportive therapies. A safe and highly effective vaccine for yellow fever is available but is often not included in national vaccination programs. Yellow fever is endemic in more than 40 countries in Africa and Central and South America and causes an estimated 200,000 cases of illness and 30,000 deaths each year.

Appendix III: Comments From the Department of Health and Human Services

DEPARTMENT OF HEALTH & HUMAN SERVICES

Office of Inspector General

Washington, D.C. 20201

AUG 22 2001

Mr. Joseph A. Christoff
Director
International Affairs and Trade
United States General
Accounting Office
Washington, D.C. 20548

Dear Mr. Christoff:

Enclosed are the Department's comments on your draft report, "Global Health: Challenges in Improving Infectious Disease Surveillance Systems." The comments represent the tentative position of the Department and are subject to reevaluation when the final version of this report is received.

The Department also provided extensive technical comments directly to your staff.

The Department appreciates the opportunity to comment on this draft report before its publication.

Sincerely,

Michael Mangano

Michael F. Mangano
Principal Deputy
Inspector General

Enclosure

The Office of Inspector General (OIG) is transmitting the Department's response to this draft report in our capacity as the Department's designated focal point and coordinator for General Accounting Office reports. The OIG has not conducted an independent assessment of these comments and therefore expresses no opinion on them.

Comments of the Department of Health and Human Services on the General Accounting Office Draft Report, Global Health: Challenges in Improving Infectious Disease Surveillance Systems (GAO-01-722)

General Comments

The Department of Health and Human Services thanks the General Accounting Office (GAO) for providing the opportunity to review GAO's draft report. Infectious disease surveillance systems, which effectively monitor disease activity and major contributing factors, sound alerts when outbreaks occur, and orient the appropriate prevention and control responses to be taken, carry out an essential function of health systems to protect the populations they serve and to limit the spread of disease.

The draft report presents an accurate and thorough evaluation of global infectious disease surveillance, giving due recognition to the importance of trained professionals, laboratory support, communications infrastructure, and an effective capacity to analyze and respond to information provided. We agree in particular with the assessment that the global framework is constrained by weaknesses in developing countries, including a lack of qualified people and equipment, weak infrastructure, and uncertain linkages between surveillance and response. Additional constraints to surveillance systems may arise from limited participation of the public, such as those resulting from the lack of safeguards to confidentiality of testing results for diseases associated with social stigmas, for example, HIV/AIDS and other sexually transmitted infections. As emphasized in the draft report, these weaknesses seriously compromise the Department's ability to understand and respond to global disease burdens and trends, and to properly protect citizens of the United States and others from new infectious disease challenges.

The report correctly states that the best-functioning surveillance systems are currently those established to support disease-specific ("vertical") priorities, such as for influenza and polio. Indeed, a major legacy of the polio eradication program will be the stronger surveillance capacity it leaves behind, including trained epidemiologists, well-functioning laboratories, and effective information systems. The report also highlights the importance of crosscutting initiatives in capacity building, such as field epidemiology training programs. Based on the Department's experience in supporting both disease-specific programs and crosscutting capacity-building programs, we believe that each offers important opportunities to improve global infectious disease surveillance and should be carried out in ways that are mutually supportive. Focused disease-specific initiatives provide models for how surveillance should be conducted for other diseases and often provide a logistics platform that can be used for their surveillance. Conversely, crosscutting programs can provide key, complementary components of an infrastructure for prevention and control needs of priority diseases. The World Health Organization's (WHO) Integrated Disease Surveillance and Response initiative, cited in the report, is an example of building incrementally on successful vertical systems to create integrated disease surveillance and response systems, something we consider to be a promising strategy for the future.

The report calls attention to the recent international commitments made to reduce the global

disease burden of HIV/AIDS, tuberculosis, and malaria. These three diseases will be further targeted by the Global AIDS and Health Fund to which the United States is contributing considerable resources. They are associated with a substantial proportion of the global infectious disease burden and investments to combat them will benefit many. However, we must be sure to address other significant infectious disease threats as well. There are continuing needs to complete the eradication of polio, to accelerate the global measles elimination campaign, to be prepared for a future pandemic of influenza and to combat childhood infections, including pneumonia and diarrhea, responsible for much of the world's preventable infant mortality. Similarly, we need to ensure that global surveillance systems are prepared to identify and respond to other emerging infectious disease threats, including dengue, yellow fever, and viral hemorrhagic fevers.

The proposed revisions to the WHO International Health Regulations offer an important channel to contribute to improved surveillance systems globally. These changes would broaden the focus of surveillance activities from three diseases (cholera, yellow fever, and plague) to all events of urgent international importance related to public health and require a capacity in each country to rapidly receive, process, and respond to information on unusual and unexpected events. Many countries will need assistance to achieve this basic capability.

Training is a critical function to confront this challenge, given the limited number of qualified personnel available for surveillance systems. To assist in addressing these training needs, the Department is making important inroads through our Centers for Disease Control and Prevention's (CDC) field epidemiology training programs (which simultaneously provide valuable epidemiologic services while training small cadres of applied epidemologists), training programs for laboratory scientists, the Sustainable Management Development Program, and our National Institute of Health's fellowships and institutional partnering programs.

As shown in such documents as CDC's global strategy paper, *Working with Partners to Improve Global Health: A Strategy for CDC and ATSDR*, and our strategy now under development for addressing global infectious diseases, the Department places a high priority on public health surveillance and is prepared to collaborate with Congress and with our external partners to strengthen this critical function.

The Department believes that GAO's draft report thoroughly reviews the importance of global surveillance of infectious disease threats and the challenges to carrying out this task, but desires to emphasize the issues addressed in these comments. We will be happy to provide additional information, as needed, to further address the challenges of improving global infectious disease surveillance.

Appendix IV: Comments From the World Health Organization

WORLD HEALTH ORGANIZATION ORGANISATION MONDIALE DE LA SANTE

Téléphone Central/Exchange: (+41 22) 791.21.11
Direct: (+41 22) 791.3425/4244
Email: druryp@who.int

In reply please refer to: CSR/ C8-370-22
Prière de rappeler la référence:

Your reference: GAO-01-722
Votre référence:

Mr Joseph A. Christoff
Director
International Affairs and Trade
United States General Accounting Office
441 G Street
NW Washington, DC 20548
USA

13 August 2001

Dear Mr Christoff,

Re: Draft Report on Global Health – Challenges in Improving Infectious Disease Surveillance Systems

Thank you for your letter of 16 July, 2001 and for the draft report on Global Health – Challenges in Improving Infectious Disease Surveillance Systems (GAO-01-722). I would like to express the appreciation of the World Health Organization (WHO) for the opportunity to review and comment on the draft report.

The draft report is well written, structured and comprehensively addresses the key features of today's surveillance systems for infectious diseases at global and national levels.

The report takes forward the work previously carried out by the General Accounting Office (GAO) in July 2000 on Global Infectious Disease Surveillance and Response. In examining the evolution and current operations of WHO's "network of networks", this draft report makes a significant contribution to the growing debate on Global Health Security: Epidemic Alert and Response.

cc: Mr Mike McAtee, Senior Analyst, GAO
Ms Ann L. Baker, International Affairs Analyst, GAO

ENCLS: (2)

Mr Joseph A. Christoff, Washington DC, USA

page 2

C8-370-22

13 August 2001

WHO's initiative in Global Health Security: Epidemic Alert and Response is addressing the key constraints identified in the draft report by improving coordination, strengthening the link to appropriate and adequate response measures, building consensual coordination mechanisms, enhancing communications, and building laboratory and epidemiology capacity. In addition, the current revision of the International Health Regulations (IHR) has received renewed impetus and endorsement from the World Health Assembly, 2001 and an increasing number of our Member States are becoming actively involved in the revision process and in pilot testing the operational mechanism being developed to support the IHR.

I have attached specific comments from the Department of Communicable Disease Surveillance and Response (CSR), previously forwarded informally by email. The comments address recent developments in WHO's strategic approach for Global Health Security, identify a number of specific areas that you might consider for further attention and offer a number of minor editorial comments.

I would like to thank the GAO team for the work that has gone into producing this Report and, in particular, Mr Mike McAtee, Senior Analyst and Ms Ann L. Baker, International Affairs Analyst, who represented the public face of the GAO when they visited Geneva for intensive discussions with the staff of the Communicable Diseases Cluster (CDS). Their professionalism and understanding of the issues involved are clearly evident in the draft report.

I look forward to receiving the final report.

Yours sincerely,

Dr David L. Heymann
Executive Director
Communicable Diseases

Appendix V: Comments From the United States Agency for International Development

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

JUL 31 2001

Mr. Joseph A. Christoff
Director
International Relations and Trade
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Christoff:

I am pleased to provide the U.S. Agency for International Development's (USAID's) formal response on the draft GAO report entitled "GLOBAL HEALTH: Challenges in Improving Infectious Disease Surveillance Systems" (July, 2001).

I wish to take this opportunity to congratulate the General Accounting Office on the excellent job they have done in responding to a Congressional inquiry on the status of infectious disease surveillance. USAID fully recognizes the complexity of this subject and feels that this draft report provides valuable insights into issues concerning the ability of public health officials to detect, tract and respond to infectious diseases. This is a subject that clearly has global significance given the potential for the spread of disease in our ever shrinking world, as well as the ability of surveillance to contribute to substantial reductions in morbidity and mortality within developing countries.

See comment 1.

The draft report, however, does not adequately describe the activities, which USAID is undertaking to respond to the deficiencies of infectious disease surveillance at the global and national levels. The draft report notes that global disease surveillance focuses attention on global disease control programs, diseases with the potential to pose serious international health problems, and diseases capable of causing disruptions to the global economy. The draft report states that "developing country systems are a weak link in the global surveillance framework." The GAO identifies several causes for the failure of developing country surveillance systems, all with which USAID would agree. However, there are some causes which are not developed fully in the draft report to which USAID would like to draw attention.

See comment 2.

Interaction between surveillance systems

The draft report makes reference to disease specific surveillance systems developed in conjunction with targeted, well-funded eradication campaigns as well as the

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WASHINGTON, D.C. 20523

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surveillance systems that address other infectious diseases. However, the draft report does not comment on the interaction between these two surveillance systems and how one affects the development of the other. In programs such as smallpox eradication, surveillance was an essential tool in the attainment of a specific goal; the eradication of the disease. In many countries the routine surveillance capabilities prior to the start of the smallpox eradication program were inadequate to achieve the target of eradication and so additional, often specialized, capacity had to be built to accommodate the program. Evidence indicates that very little of the surveillance capacity created by the smallpox eradication program was maintained after the eradication of the disease to build a surveillance system for other infectious diseases that contributed to significant morbidity and mortality. If the balance of resource flow between disease specific surveillance initiatives and routine disease surveillance remains heavily in the favor of the disease specific programs, then the ability to support overall system strengthening approaches will continue to be severely inhibited. The consequence will be persistent weaknesses in developing country surveillance and the inability of the global community to retard the spread of infectious diseases and drug resistant pathogens.

The draft report notes that current efforts to control the spread of malaria, tuberculosis and HIV/AIDS offer promise for strengthening the overall disease surveillance capacity in developing countries. But the draft report does caution that "the extent to which the global public health community can manage new disease-specific initiatives in a manner that significantly improves surveillance for all infectious disease threats remains to be demonstrated." This is a critically important statement that is supported by donors' failure in the past to use disease specific initiatives to support broader health development goals. With respect to the current polio eradication program, USAID has adopted an approach that seeks to fulfill the eradication objective in a manner that also supports broader development concerns and leaves developing countries with a sound surveillance platform upon which to build the capacity to monitor and respond to other infectious diseases. This approach is a basic principal upon which the USAID Polio Eradication Initiative is constructed. Some examples how we anticipate polio eradication supporting surveillance for other infectious diseases are:

- The polio eradication initiative has focused on the development of a global laboratory network for the diagnosis of polio. While this network is primarily focused on enteroviral detection, it still remains a valuable resource for strengthening national and global laboratory capacity after the polio program has been concluded.

- USAID developed a manual for polio surveillance, through the Change Project, that also trains health workers in the detection of other diseases (measles, cholera, meningitis, neonatal tetanus, and yellow fever) at the same time as they are looking for acute flaccid paralysis (AFP). This takes full advantage of the opportunity to enhance polio surveillance beyond the scope on just one disease.

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- A vast network of epidemiologists has been assembled in polio endemic countries to manage the AFP surveillance program. If this network can be maintained and linkages built to the current surveillance systems, after the conclusion of the polio program, it will serve as a critical resource for monitoring other infectious diseases and strengthening the ability of countries to investigate outbreaks as they occur.

Developing broad surveillance capacity

While USAID remains committed to see that disease specific programs are implemented in a manner that maximizes the spin-off benefits for the developing countries as well as the global community, there are limitations as to what can be done to strengthen overall disease surveillance capability through this approach. Many of the weaknesses of developing country programs that the draft report documents require donor attention outside of the range of disease specific programs. USAID is focused on these areas in an attempt to improve the overall disease surveillance capacity in countries receiving US development assistance. USAID implements activities through its central bureaus, its regional bureaus, direct Mission support at the country level and in bilateral programs between host countries and USAID Missions. Examples of the areas where USAID is strengthening national, regional, and global infectious disease surveillance capacity are:

- The USAID Bureau for Africa has made several grants to the African Regional Office (AFRO) of the World Health Organization (WHO) to support Integrated Disease Surveillance and Response Initiative that is mentioned on page 37 of the draft report. In this initiative, not only is USAID providing the means to conduct country surveillance assessments, develop regional surveillance guidelines, and support national implementation plans for improved infectious disease surveillance throughout the Africa region, but it also is strengthening African regional capacity, and regional institutions. USAID also provides significant resources to the Centers for Disease Control and Prevention to provide technical assistance in support of IDSR.

- USAID has long been a supporter of the establishment of Field Epidemiology Training Programs (FETP) throughout the world. Through work with the Centers for Disease Control and Prevention, USAID is developing FETPs that train developing country health staff in the principals and practice of field based epidemiological investigations. In addition, USAID is also providing funding to the WHO in Geneva to conduct epidemiological investigations and is currently developing a grant to the Training Programs In Epidemiology and Public Health Interventions Network (TEPHINET), a PVO that supports FETPs in more than a dozen countries around the world.

- Through the USAID Environmental Health Project, the agency is developing a Geographic Information Systems (GIS) that is used in the improvement of disease surveillance for malaria. This work is taking place in Eritrea,

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Mozambique and Nepal. The focus is to establish ways for local health authorities to better use surveillance information in their malaria control efforts so that resources are not wasted and a greater health impact can be achieved at a lower overall cost.

- The USAID Bureau for Europe and Eurasia has recently made a grant to the European Regional Office of the WHO for development of a vaccine preventable disease surveillance program in Eastern Europe and the Newly Independent States. This activity is the expansion of a program that USAID conducted in Ukraine to introduce a new method of local control over disease surveillance as opposed to the cumbersome and slow central approach used in the former Soviet Union. This highly successful approach will now be introduced in other countries in the region by a joint effort of WHO and USAID.

- USAID Bureau for Africa has fully supported a CDC laboratory expert to work with the African Regional Office of the WHO to improve the laboratory capacity at the national and regional levels in Africa. In addition, USAID is currently working with WHO/Geneva to develop a Quality Control/Quality Assurance program for national laboratories in Africa. This activity is being conducted through the newly established laboratory strengthening program in Lyon, France. This center is referenced in the draft report on page 33.

- The USAID Bureau for Latin America and the Caribbean (LAC) is starting an initiative for anti-microbial resistance surveillance for pathogens causing respiratory disease and diarrhea. The initiative strengthens national level laboratory capacity in Bolivia, Peru, Paraguay, El Salvador, Guatemala and Nicaragua with future training planned for the Dominican Republic and Honduras. The Malbran Laboratory in Argentina is being developed to act as the quality control body.

- The USAID LAC Bureau has established a field epidemiology training program (FETP) in the seven countries affected by hurricanes Mitch and Georges; i.e. Costa Rica, El Salvador, Dominican Republic, Guatemala, Haiti, Honduras, and Nicaragua. They are also rehabilitating public health laboratories in these countries as well as strengthening the laboratory network involving the countries of the Amazon Basin and the "Southern Cone" of South America.

- USAID has recently established an agreement with the Ministry of Health in Tanzania to provide technical assistance for the development of a national disease surveillance system. This work is focusing attention on building information gathering and analysis capabilities at the district level, supporting the development of a national public health laboratory and developing a rapid response capability that can investigate and respond to infectious disease

5

outbreaks. Similar work of this nature is being conducted in Ghana, Uganda, Mozambique and Ethiopia.

- USAID is engaged in research into the development of simple diagnostics that can be used to accurately detect a disease with a minimum of laboratory capacity. The technology for a malaria diagnostic has been developed and tested by the Healthtech Project and has been transferred to the private sector for full production. Other simple diagnostic technologies for HIV, syphilis, tuberculosis, anemia, gonorrhea, and chlamydia are currently under development or have already been developed through USAID's Healthtech Project.

- The LAC Bureau has provided substantial support to strengthening surveillance capacity for Malaria under the VIGIA Project in Peru. In addition, the Bureau will launch the Amazon Malaria Initiative this year which will focus on setting up a surveillance network in Brazil, Bolivia, Ecuador, Guyana, Columbia, Peru, Venezuela and Surinan.

- Through USAID's Infectious Disease Initiative and the HIV/AIDS program, the agency is refining and strengthening surveillance capacity for HIV/AIDS and tuberculosis. Global surveillance networks are in place for these diseases but they need to be further strengthened and extended to the national and sub-national levels.

- In the Asia/Near East Region, USAID is supporting improvements in surveillance systems at both the country and regional levels. Much of the work focuses on improving the collection, analysis, and dissemination of surveillance information for specific diseases such as HIV/AIDS, sexually transmitted infections, malaria, tuberculosis, polio, dengue, Japanese encephalitis, and viseral leishmaniasis. Surveillance is also being strengthened for monitoring anti-microbial resistance and behaviors related to the transmission of the previously mentioned diseases. In addition, laboratory capacity, quality assurance, and networking of sub-national and national institutions are being improved with USAID assistance.

As the draft report notes, the detection of outbreaks of infectious diseases is a critical role for national and global surveillance systems. However, it should be kept in mind that disease outbreaks do not account for the majority of mortality and morbidity in developing countries. Surveillance that is focused on "routine" illnesses needs to be strengthened in a fashion that allows countries to utilize their limited resources more effectively, to promote better policy decisions, and to organize health services in a way that best serves the promotion of the population's overall health. Activities that need to be conducted for this type of disease surveillance are usually not within the range of disease-specific surveillance and require special consideration. While routine surveillance is not as visible on the global stage as disease specific programs such as smallpox and polio, the potential for improvements in health status and mortality

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reduction is as great or greater than the vertical programs. Without recognition of this fact, a significant opportunity will be lost.

Specific corrections

See comment 3.

Now on p. 39.
See comment 4.

Finally, several specific corrections in the draft report deserve to be mentioned. Page 26 of the draft report notes that with reference to malaria, tuberculosis and HIV/AIDS, "none of these three diseases elicits a clear and effective response from the human immune system." USAID would like to suggest that more accurate wording would be "unlike many infectious diseases such as measles and pertussis, malaria, tuberculosis and HIV/AIDS do not produce an adequate long-lasting post infection immunity." On Page 37, the draft report implies that IDSR has only conducted baseline assessments in 10 of 46 countries while the goal involved only 23 countries that requested inclusion in the initiative. As of April 2001, 20 of 23 countries had conducted assessments and 13 of 20 countries had developed detailed plans of actions.

Thank you for the opportunity to respond to the GAO draft report and for the courtesies extended by your staff in the conduct of this review.

Sincerely,

Richard C. Nygard
Acting Assistant Administrator
Bureau for Management

GAO Comments

1. We reviewed the examples of relevant USAID activities provided on pages 3-5 of the agency's written comments and inserted into the report references to those activities that could be included in the text. For example, we added a reference to USAID support to our existing discussion on "Coordinating Surveillance Operations."

2. We revised the draft report's concluding observations to reflect USAID's subsequent comments that past disease-specific initiatives have failed to improve overall developing country surveillance capacity, many of the weaknesses of developing country programs identified in the report require donor attention outside the range of disease specific programs, if the balance of resource flows between disease-specific surveillance initiatives and routine surveillance remains heavily in favor of the former, then the ability of the donor community to support overall system strengthening will continue to be severely inhibited.

3. We retained the original language after consulting with experts on these diseases at CDC and the Case Western Reserve University School of Medicine.

4. We retained the original wording, with the qualification that the information cited was accurate as of April 9, 2001. As of this date, after detailed communications with WHO's Africa Regional Office, we had received 19 completed assessments and 10 completed plans of action. We were informed, in addition, that health officials had conducted fieldwork in a 20th country, Kenya, but that their assessment report was not yet available.

   No change was made to reflect the comment that the goal of the Integrated Disease Surveillance and Response initiative "involved only 23 countries that requested inclusion in the initiative." No reference to such requests was made to us during the course of our work with WHO or the countries involved in the initiative.

Appendix VI: Comments From the National Aeronautics and Space Administration

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

Reply to Attn of: YO

JUL 30 2001

Joseph A. Christoff
Director
International Affairs and Trade
United States General Accounting Office
Washington, DC 20548

Dear Mr. Christoff:

We appreciate the opportunity to review and provide comments to the draft report, entitled Global Health; Challenges in Improving Infectious Disease Surveillance Systems. We have reviewed the report in detail. NASA concurs with the overall contents of the report. In particular, we concur with the conclusions regarding the potential for employing disease-mapping systems to predict disease outbreaks and trends in relation to climate and weather patterns as well as their present limitations. These limitations are "constrained by the quality of available data on diseases and underlying features such as population distribution and the locations of health facilities and water supplies, as well as limited access to satellite-generated information."

If further assistance is required, please contact Mr. Ed Sheffner, Applications Theme Lead for Environmental Assessment, on (202)358-0239.

Sincerely,

Ghassem R. Asrar
Associate Administrator for
Earth Science Enterprise

cc:
YO/E. Sheffner

Appendix VII: Comments From the World Bank

The World Bank
Washington, D.C. 20433
U.S.A.

JOZEF RITZEN
Vice President
Human Development Network

July 31, 2001

Ms. Jan Piercy
Executive Director

Dear Jan,

Re: GAO Disease Surveillance Report

Thank you for sharing the draft copy of the GAO's report on Challenges in Improving Infectious Disease Surveillance Systems.

We strongly agree that strengthening health surveillance systems is a global priority, particularly as all partners strive to show results in controlling communicable diseases such as HIV/AIDS, malaria, tuberculosis and many of the vaccine preventable killers. The analysis in the report provides a useful overview of the systems, players and experiences to date.

As noted in the GAO report, existing systems are weak, particularly in the poorest countries. As part of its emphasis on health, the World Bank is actively working with a number of governments to strengthen national surveillance systems.

We welcome this timely and important report, and hope it will contribute to stimulating greater action on the part of all partners.

Sincerely yours,

Jozef Ritzen

Appendix VIII: Comments From the Department of Defense

THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D. C. 20301-1200

HEALTH AFFAIRS

AUG 22 2001

Mr. Joseph A. Christoff
Director, International Affairs and Trade
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Christoff:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "GLOBAL HEALTH: Challenges in Improving Infectious Disease Surveillance Systems," dated July 16, 2001 (GAO Code 711544). The DoD has reviewed the draft report and concurs with comment.

The Department of Defense Global Emerging Infectious Surveillance and Response System (DoD-GEIS), has significantly contributed to national efforts to support worldwide infectious disease surveillance. The report does not adequately reflect DoD's surveillance efforts to protect deployed US military personnel, US citizens living and traveling abroad, and the world population as a whole.

Internationally, through the use of overseas laboratories, DoD-GEIS conducts substantial collaborations with institutions in 38 countries around the world. Their work focuses on surveillance for drug-resistant malaria, antibiotic-resistant enteric organisms, influenza, and unexplained febrile illness. The findings from surveillance sponsored by DoD-GEIS have already led to changes in therapeutic policies and practices in several areas of the world.

Additional comments on the draft report are included in the enclosure. The DoD appreciates the opportunity to comment on the draft report.

Sincerely,

J. Jarrett Clinton, MD, MPH
Acting Assistant Secretary

Enclosure:
As stated

Appendix IX: GAO Contact and Staff Acknowledgments

GAO Contact

Michael McAtee (202) 512-8978

Acknowledgments

In addition to the person named above, key contributors to this report were Ann Baker, Lynn Cothern, Kay Halpern, Lynne Holloway, John Hutton, Bruce Kutnick, and Tom Zingale.

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