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NEW, EMERGING, AND RE-EMERGING INFECTIOUS DISEASES

In recent years considerable attention has been given to the serious threat posed by new, emerging, and re-emerging infectious diseases. The magnitude of the problem is illustrated by the appearance of several new pathogens causing disease of marked severity, such as the human immunodeficiency virus (HIV) and other retroviruses, arenaviruses, hantaviruses, and Ebola virus. Simultaneously, old pathogens, including those which cause cholera, plague, dengue hemorrhagic fever, and yellow fever, have re-emerged and are having a considerable impact in the Americas. Microorganism mutations leading to drug and multi-drug-resistant strains of *mycobacterium*, *tuberculosis*, enterobacteria, staphylococci, pneumococci, gonococci, malaria parasites, and other agents have been occurring continuously and are becoming major obstacles to the control of these infections. Some of these infections exhibit a focal geographic distribution, whereas others are widely dispersed and, in some cases, tend to become a global problem.

In response to this alarming trend, in June 1995 PAHO convened a meeting of international experts to discuss strategies for the prevention and control of new, emerging, and re-emerging diseases. As result of this meeting, a Regional Plan of Action was prepared to develop regional and subregional approaches and to guide Member States in addressing specific problems.

The Directing Council is requested to consider the Regional Plan of Action and provide feedback to the Secretariat, particularly in relation to its four goals:

- Strengthening regional surveillance networks for infectious diseases in the Americas;
- Establishing national and regional infrastructures for early warning of and rapid response to infectious disease threats through laboratory enhancement and multidisciplinary training programs;
- Promoting the further development of applied research in the areas of rapid diagnosis, epidemiology, and prevention;
- Strengthening the regional capacity for effective implementation of prevention and control strategies.

CONTENTS

	<i>Page</i>
Executive Summary	3
1. Introduction	5
2. Emerging Infectious Diseases in the Americas	6
3. Regional Plan of Action	9
3.1 Goals and Objectives	9
3.2 Strategies	12
4. Bibliography	18

EXECUTIVE SUMMARY

In recent years considerable attention has been given to the serious threat posed by new, emerging, and re-emerging infectious diseases. Emerging diseases are defined as those whose incidence in humans has increased in the past two decades, and re-emergence is the reappearance of a known disease after a significant decline in incidence. The magnitude of the problem is illustrated by the appearance of several new pathogens causing disease of marked severity, such as the human immunodeficiency virus (HIV) and other retroviruses, arenaviruses, and hantaviruses, all of which are present in the Americas. Simultaneously, old pathogens, such as cholera, plague, dengue hemorrhagic fever, and yellow fever, have re-emerged and are having considerable impact in the Americas.

Microorganism mutation leading to drug and multi-drug resistant strains of *Mycobacterium tuberculosis*, enterobacteria, staphylococci, pneumococci, gonococci, malaria parasites, and other agents has been occurring continuously and is causing major problems in the control of these infections in many parts of the world, including the Region of the Americas.

In June 1995 the Pan American Health Organization convened a meeting of international experts to discuss strategies for the prevention and control of these diseases. As a result of this meeting, a Regional Plan of Action was prepared to provide guidance to Member States in addressing specific problems and in implementing regional and subregional measures.

The Plan has four goals:

Goal 1: Strengthening regional surveillance networks for infectious diseases in the Americas

The purpose of regional surveillance networks is to provide the vigilance and rapid response capability required to better detect, contain, and prevent new and resurgent infectious diseases in the Americas. Such networks should monitor infectious agents, the diseases they cause, and the factors influencing their emergence. Well-run surveillance networks are invaluable tools for disease monitoring and assessment. Specifically, surveillance serves to: characterize disease patterns by time, place, and person; detect epidemics; generate hypotheses for epidemiologic investigation; evaluate prevention and control programs; project future health care needs; and lower health care expenditures by facilitating earlier implementation of intervention strategies. Surveillance networks that are closely linked with reference diagnostic support function as early warning systems for emerging infections.

Goal 2: Establishing national and regional infrastructures for early warning of and rapid response to infectious disease threats through laboratory enhancement and multidisciplinary training programs

Careful design of the components needed to ensure appropriate resource development and integration of those resources among local, national, subregional, and regional partners should facilitate the establishment of truly useful infrastructures. Components of a program for early warning and rapid response to emerging infections should include: (1) human resources; (2) facilities for laboratory, clinical, and training support; (3) appropriate communications networks; (4) an organizational structure that integrates the different infrastructural elements, and provides for basic logistical support (e.g., procurement, specimen handling/storage, and shipping of specimens to reference facilities); (5) political/governmental support that integrates the program into overall national health priorities; and (6) a long-term plan for fiscal support and budgetary management.

Goal 3: Promoting the further development of applied research in the areas of rapid diagnosis, epidemiology, and prevention

With the exception of Region-wide emerging infectious threats such as cholera, tuberculosis, and HIV, disease-specific research priorities will likely be developed on a country-by-country basis. Some general principles, however, can be used when assessing priority applied research needs for new and emerging infections in the Americas. For purposes of discussion, these principles can be classified into three broad categories: diagnostics, epidemiology/prevention effectiveness, and clinical studies.

Goal 4: Strengthening the regional capacity for effective implementation of prevention and control strategies

Prevention and control strategies will complement Goals 1-3 and can be viewed as the "action" and "feedback" components of the Regional Plan of Action. Emphasis will be placed on information dissemination systems/programs, aggressive efforts to develop and rapidly implement educational programs on antimicrobial resistance, and enhancement of emergency response and outbreak control measures.

1. Introduction

In recent years considerable attention has been given to the serious threat posed by new, emerging, and re-emerging infectious diseases. Emerging diseases are defined as those whose incidence in humans has increased in the past two decades, and re-emergence is the reappearance of a known disease after a significant decline in incidence. The magnitude of the problem is illustrated by the appearance of several new pathogens causing disease of marked severity, such as the human immunodeficiency virus (HIV) and other retroviruses, arenaviruses, hantaviruses, and Ebola virus. Simultaneously, old pathogens, such as cholera, plague, dengue hemorrhagic fever, and yellow fever, have re-emerged and are having considerable impact in the Americas.

Microorganism mutations leading to drug and multi-drug-resistant strains of *M. tuberculosis*, enterobacteria, staphylococci, pneumococci, gonococci, malaria parasites, and other agents have been occurring continuously and are becoming major obstacles to the control of these infections.

Some of these infections exhibit a focal geographic distribution, whereas others are widely dispersed and, in some cases, are global in their extent.

A milestone in addressing this alarming trend was the document "Emerging Infections: Microbial Threats to Health in the United States," published in 1992 by the Institute of Medicine of the US National Academy of Sciences. This publication gained considerable attention in the United States and in international fora. In the United States, the Centers for Disease Control and Prevention (CDC) responded to the issue by preparing a comprehensive plan, and other agencies such as the National Institutes of Health (NIH), the Department of Defense (DOD), and the Committee on International Science, Engineering, and Technology (CISSET) are finalizing their plans. Canada has also prepared a document containing recommendations on emerging diseases. The WHO has held two meetings of experts to address the issue, and a resolution aimed at responding to the problem was adopted during the Forty-eighth World Health Assembly in May 1995.

In June 1995 the Pan American Health Organization convened a meeting of international experts to discuss strategies for the prevention and control of these diseases. As a result of this meeting, a Regional Plan of Action was prepared to provide guidance to Member States in addressing specific problems and in implementing regional and subregional measures.

2. Emerging Infectious Diseases in the Americas

In the Americas, a complex array of factors has contributed to the recognition of an increasing number of new, emerging, and re-emerging infectious diseases in both developed and developing nations. Cholera, for example, returned to the Western Hemisphere in epidemic proportions in 1991. Since then, over one million cases and 9,000 deaths have occurred. In 1993 and 1994, the number of reported cases decreased in some countries but continued to increase in several areas of Central America, Brazil, and Argentina. PAHO has estimated that it will take more than a decade and over US\$ 200 billion to control the regional epidemic. Factors contributing to the resurgence of cholera include poor public sanitation, inadequate water treatment, and high levels of poverty associated with unsatisfactory living conditions. The cholera problem also illustrates how factors in one continent may affect global health through increased microbial traffic to distant regions.

In Peru, sporadic cases of human plague have been reported for the past 40 to 50 years. However, in October 1992, a plague epidemic emerged. By the end of 1994, a total of 1,299 cases were diagnosed, with 62 deaths and a case fatality rate of 4.8%.

Antimicrobial drug resistance is perhaps one of the most alarming threats among the problems presented by new and emerging infections. The problem is well documented in the United States where increasing levels of drug resistance in both community-acquired (e.g., multi-drug-resistant *Streptococcus pneumoniae*) and nosocomial infections (e.g., vancomycin-resistant enterococci) have led infectious disease experts to declare the situation a crisis that could lead to a "post-antibiotic" era. Although less well-documented, the detection of significant levels of antimicrobial drug resistance is increasing in Latin America where, for example, over 20% of strains of *S. pneumoniae* have diminished susceptibility to penicillin. Resistance is also spreading among Latin American strains of *Shigella*, and high-level resistance is anticipated to develop in *Salmonella typhi* in the near future. Although documentation is limited, the threat of antimicrobial resistance in the developing nations of the Western Hemisphere appears to outweigh that present in the United States and Canada. Resistant *Plasmodium falciparum* malaria is now present throughout *P. falciparum*-endemic regions in South America. Resistance to chloroquine was soon followed by resistance to sulfadoxine-pyrimethamine combinations. Diminished sensitivity to quinine has been reported in Brazil. Conditions that encourage the development of antimicrobial resistance are widespread throughout Latin America: over-the-counter sale of antibiotics and frequent self-medication; overcrowding and suboptimal infection control practices in many hospitals; minimal regulation of antibiotic usage within or outside hospitals; scarce documentation of clinical trial results for newer antibiotics; and almost nonexistent surveillance and reporting of antimicrobial resistance patterns.

Human immunodeficiency virus infection/acquired immunodeficiency syndrome (HIV/ AIDS) may be the most devastating example of the potential impact of a newly emerging infectious disease on global public health. The HIV/AIDS pandemic has been pivotal in drawing the attention of public health experts to the problem and to the need for increased surveillance and research. HIV and other sexually transmitted diseases (STDs) illustrate the impact of changes in demographic conditions, social standards, modification of the global environment, and the mutability of microorganisms. The discovery of HIV has also led to the identification of other etiologic agents with similar modes of transmission through sexual contact, blood contamination, and perinatal acquisition, such as HTLV-I- and HTLV-II-associated myelopathy/tropical spastic paraparesis in the Caribbean and Brazil.

The Pan American Health Organization estimates that over 1.5 million people in Latin America and the Caribbean are infected with HIV and that by 1999 the cost of caring for AIDS patients in the entire Region will exceed \$2,000 million. The dramatic impact of HIV/AIDS on public health is due in large part to the multiple opportunistic infections that develop in association with this condition. Data from Brazil, Honduras, Argentina, and Mexico indicate that tuberculosis is the most common opportunistic infection in the Region, afflicting over 330,000 persons in 1992. Co-infection with HIV and *M. tuberculosis* substantially increases the pool of individuals with active pulmonary disease, thus increasing the risk of contagion to both immunosuppressed and non-immunosuppressed persons. In addition, such patients frequently harbor strains of *M. tuberculosis* with multiple drug resistance. This complex interplay between HIV and *M. tuberculosis*, in association with decreasing support for tuberculosis surveillance and control programs, accounts for part of the recent resurgence of this condition in the United States of America, where direct costs for tuberculosis treatment in 1991 alone exceeded \$700 million. The economic impact in Latin America and the Caribbean has yet to be documented.

HIV/AIDS is interacting with new and emerging infectious diseases in other ways as well. Common tropical diseases in Latin America, such as Chagas' disease, are presenting with varied and unusual clinical manifestations in persons with HIV/AIDS. Moreover, experience with some HIV-related infections has led to their increased recognition in broader populations, such as *Cryptosporidium* in diarrheal disease outbreaks associated with childcare facilities and contaminated municipal water supplies in the United States. Even "new" diseases such as human microsporidiosis are being recognized with increasing frequency because of the expanding population of persons with HIV/AIDS. Three new species of microsporidia (*Enterocytozoon bieneusi*, *Encephalitozoon hellem*, and *Encephalitozoon* [formerly *Septata*] *intestinalis*) were first described in HIV-infected individuals from North America and the Caribbean. HIV has also been found to affect susceptibility to cervical and other cancers. In the case of another sexually transmitted agent, human papillomavirus (HPV), the relationship

between certain strains of HPV and the development of cervical cancer have been well established. Cervical cancer, the leading cause of death from cancer among women in developing countries, is expected to increase because HIV-induced immunosuppression facilitates HPV-induced neoplasia.

Although worldwide in scope, the emergence of dengue and dengue hemorrhagic fever (DHF) as a major public health problem has been most dramatic in the Americas, where the mean annual number of reported DHF cases between 1989 and 1993 increased over 60-fold as compared to the preceding five-year period (1984-1988). Dengue has now become hyperendemic (types 1, 2, and 4) in many countries in the American tropics; during the last 10 years, five countries in South America have experienced major epidemics, following a period of over 50 years in which the disease was largely absent. The geographic distribution of *Aedes aegypti* in 1995 is similar to its distribution prior to the successful eradication campaigns of the 1950s and 1960s. As of this year, 15 countries in the Region of the Americas had reported confirmed cases of DHF, and DHF is now endemic in many of these countries. In 1994 dengue type 3 virus activity was detected in Nicaragua and Panama and in 1995, in Costa Rica, Honduras, and El Salvador, representing the first reappearance of this strain in the Americas in 16 years.

The South American arenaviruses provide an important example of how exploitation of new areas for human settlement and agriculture will increase the likelihood that new infectious diseases will emerge. A new member of this group of rodent-borne viruses has been discovered on an average of every three years since the first was isolated in 1956. Some are not pathogenic for humans, but five cause human disease and three of these cause important health problems in Argentina (Junín virus: Argentine hemorrhagic fever), Bolivia (Machupo virus: Bolivian hemorrhagic fever), and Venezuela (Guanarito virus: Venezuelan hemorrhagic fever). The pattern of these emerging infections is that humans become involved when they enter new areas where viruses are circulating among wild rodents and that the viruses may spread to involve wide geographic areas.

Yellow fever mainly affects five countries of the tropical Americas. It occurs sporadically or causes relatively small outbreaks among persons exposed to the infection in forests where it is enzootic. The disease re-emerged with dramatic force in Peru in 1995, causing the largest outbreak in the country's history. Nearly 400 cases have been notified (provisional figure), with a case-fatality rate approaching 50%.

Vulnerability to emerging infections is not limited to the developing nations of tropical America. In 1993, the United States experienced the largest waterborne disease outbreak ever recognized there. The source was an urban municipal water supply contaminated with *Cryptosporidium*—an intestinal parasite that causes prolonged diarrheal

illness in the immunocompetent and severe, often life-threatening, disease in the immunosuppressed. Also in 1993, the emerging bacterial pathogen *Escherichia coli* O157:H7 caused a multi-state foodborne outbreak of hemorrhagic colitis and hemolytic uremic syndrome, with at least four deaths among infected children.

Likewise, a previously unknown hantavirus was identified in the four-corner area of the United States (Arizona, Colorado, New Mexico, and Utah) as the etiologic agent of hantavirus pulmonary syndrome. This infection, which was linked to exposure to infected rodents, has affected primarily otherwise healthy young adults and has demonstrated a cumulative mortality approaching 50%. Over 100 cases have been identified in 22 states in the United States; Canada has reported seven cases. Elsewhere in the Americas, recognition of hantavirus is also increasing. Three cases, with two deaths, have been confirmed in Brazil, while Argentina has recently released data suggesting that three outbreaks of hantavirus pulmonary syndrome occurred in that country between 1991 and 1995.

3. Regional Plan of Action

The Plan is presently being prepared by PAHO, and its purpose is to provide Member States with guidance in preparing national plans and addressing specific problems.

3.1 Goals and Objectives

The goals and objectives of the Plan are as follows:

Goal 1: Strengthening regional surveillance networks for infectious diseases in the Americas

The purpose of regional surveillance networks is to provide the vigilance and rapid response capability required to better detect, contain, and prevent new and resurgent infectious diseases in the Americas. Such networks should monitor infectious agents, the diseases they cause, and the factors influencing their emergence. Well-run surveillance networks are invaluable tools for disease monitoring and assessment. Specifically, surveillance serves to: characterize disease patterns by time, place, and person; detect epidemics; generate hypotheses for epidemiologic investigation; evaluate prevention and control programs; project future health care needs; and lower health care expenditures by facilitating earlier implementation of intervention strategies. Surveillance networks that are closely linked with reference diagnostic support function as early warning systems for emerging infections.

Objective 1-A: Provide the regional leadership and coordination needed to enhance and integrate existing infectious disease surveillance networks in the Americas to ensure adequate vigilance for new, emerging, and re-emerging infectious diseases.

Objective 1-B: Establish a regional steering committee for emerging infectious disease surveillance that will develop priorities for regional surveillance and work closely with other regional efforts to enhance surveillance.

Objective 1-C: Develop uniform guidelines for Member States that programmatically link surveillance and reference diagnostic services, emphasizing that such services are inherent governmental functions and responsibilities.

Goal 2: Establishing national and regional infrastructures for early warning of and rapid response to infectious disease threats through laboratory enhancement and multidisciplinary training programs

Careful design of the components needed to ensure appropriate resource development and integration of those resources among local, national, subregional, and regional partners should facilitate the establishment of truly useful infrastructures. Components of a program for early warning and rapid response to emerging infections should include: (1) human resources; (2) facilities for laboratory, clinical, and training support; (3) appropriate communications networks; (4) an organizational structure that integrates the different infrastructural elements, provides for basic logistical support (e.g., procurement, specimen handling/storage, and shipping of specimens to reference facilities); (5) political/governmental support that integrates the program into overall national health priorities; and (6) a long-term plan for fiscal support and budgetary management.

Objective 2-A: Develop an organizational structure that integrates the different infrastructural elements, provides for basic logistical support (e.g., procurement, specimen handling/storage, and shipping of specimens to reference facilities), and has sufficient political/governmental support to integrate the program into overall national health priorities.

Objective 2-B: Develop a long-term plan for fiscal support and budgetary management.

Objective 2-C: Establish mechanisms to assign, redeploy, and maintain the necessary human resources through training and career development programs.

Objective 2-D: Secure the necessary facilities for laboratory-based diagnosis and research, clinical evaluation and care, and training.

Objective 2-E: Develop communications links among program participants that are "level-appropriate" and emphasize feedback to and participation of communities.

Goal 3: Promoting the further development of applied research in the areas of rapid diagnosis, epidemiology, and prevention

With the exception of Region-wide emerging infectious threats such as cholera, tuberculosis, and HIV, disease-specific research priorities will likely be developed on a country-by-country basis. Some general principles, however, can be used when assessing priority applied research needs for new and emerging infections in the Americas. For purposes of discussion, these principles can be classified into three broad categories: diagnostics, epidemiology/prevention effectiveness, and clinical studies.

Objective 3-A: Develop rapid, simple, and cost-effective diagnostic techniques for emerging pathogens of importance in the Americas.

Objective 3-B: Expand efforts in epidemiologic and prevention effectiveness research.

Objective 3-C: Develop clinical research protocols designed to answer critical questions on pathogenesis and a spectrum of emerging infections.

Goal 4: Strengthening the regional capacity for effective implementation of prevention and control strategies

Prevention and control strategies will complement Goals 1-3 and can be viewed as the "action" and "feedback" components of the Regional Plan of Action. Emphasis will be placed on information dissemination systems/programs, aggressive efforts to develop and rapidly implement educational programs on antimicrobial resistance, and enhancement of emergency response and outbreak control measures.

Objective 4-A: Develop programs for the appropriate dissemination of prevention guidelines and other critical information on emerging infections.

Objective 4-B: Educate both the health consumer and provider about the inappropriate use of antibiotics and the development of antimicrobial resistance.

Objective 4-C: Enhance regional outbreak control measures.

3.2 Strategies

The following strategic approaches have been established for each of the defined goals of the Regional Plan of Action.

3.2.1 *Strengthening regional surveillance networks for infectious diseases in the Americas*

Several surveillance networks are presently functioning in the Americas. Some of these networks, such as those for polio and measles, were established as part of eradication programs. Their role has been very valuable in documenting the elimination of these diseases. The cholera network was established after the re-emergence of this disease in the Americas and provides useful information on its distribution in the Region. The WHONET was developed by the World Health Organization for use in laboratories to monitor antimicrobial resistance and guide the selection of antibiotics, and to identify resistance and quality control problems, at both national and international levels. The influenza and dengue networks and the WHO Collaborating Centers are examples of other networks making significant contributions to the surveillance of infectious diseases in the Americas. In addition, the Caribbean Epidemiology Center (CAREC), the Pan American Foot-and-Mouth Disease Center (PANAFTOSA), and the Pan American Institute for Food Protection and Zoonoses (INPPAZ) have important functions in the surveillance of human and animal diseases. It should also be noted that the Integrated Border Information and Surveillance System (IBISS) for monitoring health events in the United States-Mexico border region is currently under development.

Regional leadership and coordination are necessary to enhance these existing capacities by strengthening and linking established laboratories and surveillance facilities. Advantage should be taken of modern technologies in information management, exchange, and dissemination, such as geographic information systems (GIS), the Public Health Laboratory Information System (PHLIS), and the Internet and World Wide Web (WWW) connections.

Consideration should be given to establishing a regional committee for emerging infectious disease surveillance to develop priorities and enhance regional surveillance, in close coordination with the countries of the Region. The committee could include representatives of leading institutions in these countries.

The purpose of the surveillance should be to detect, promptly investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence. In this context, three lines of surveillance should be considered:

- **Micropathogen surveillance.** This approach would rely on laboratory-based surveillance and should utilize techniques for isolation or culture of etiological agents, serological testing, and monitoring of antimicrobial resistance.
- **Syndrome surveillance.** The system would use existing capacities for routine and sentinel surveillance, including public and private hospitals and health clinics. The syndromes to monitor would include respiratory failure of unknown etiology, encephalitis and aseptic meningitis, hemorrhagic fevers (febrile illness with thrombocytopenia), febrile illness with rash, acute flaccid paralysis, dysentery/acute febrile diarrhea with blood and or mucus, and unexplained jaundice.
- **Surveillance of selected specific factors known to be associated with an emerging infectious disease, such as environmental changes and food handling practices.**

3.2.2 Establishing national and regional infrastructures for early warning of and rapid response to emerging infectious disease threats through laboratory enhancement and multidisciplinary training programs

To establish the appropriate infrastructure to respond to a new disease threat, human resources, facilities for laboratory capacities and clinical training, communications, logistical support, and organizational structure must be developed.

Appropriately trained personnel will be a critical component of the infrastructure needed for early warning and rapid response. Training programs should be carried out in partnership with the numerous national institutions that provide such training in the Americas. Particularly important will be the development of education and training activities targeted at practical issues of disease surveillance, recognition, and response. These activities should focus on the country-level medical community to facilitate appropriate specimen collection and handling, the laboratory resources for optimum specimen processing, and the intelligent utilization of data obtained by program managers. Training should also target country-level laboratory personnel. Collaborative programs with organizations in the United States of America and other countries are needed to train specialists in state-of-the-art, field-applicable, and cost-effective technologies.

Career development is essential. There must be a system for training skilled personnel for each of these roles and a career path to ensure retention. This is especially true for surveillance (both laboratory and epidemiologic), where there is often no developed career path and no career incentive. At both regional and national levels, contacts and partnerships with appropriate professional groups (and the development of appropriate groups, when none exist) should be encouraged.

It is necessary to define the complement of minimal laboratory (and epidemiologic) capabilities that should be available at each level (from the local, through national, to subregional and regional), develop guidelines and standard procedures, and assist governments in implementing these guidelines. There is also a need for a comprehensive survey of suitable laboratory and epidemiological facilities and for an assessment of their capabilities. This should be done through questionnaires and (as necessary) visits. As a start, all known laboratory networks should be listed and assessed. Regional quality assurance and quality control programs for diagnostic laboratories need to be implemented. Guidelines should be available for sample collection, handling, and storage. Regional self-sufficiency in diagnostics is a goal, with the more specialized reagents produced, at least initially, by appropriate specialized laboratories; the reagents would then be standardized and inventoried regionally. Technology transfer of laboratory diagnostic tests should be encouraged, including appropriate ways to evaluate and utilize tests that might be of particular value in the Region.

Different communication mechanisms are appropriate at different levels, with fax and electronic communications being the major options beyond the local level. Implementing a small number of well-standardized and well-established systems, such as PHLIS (with EPI-INFO) and WHONET (for antimicrobial resistance data), would facilitate data sharing and coordination.

Logistical support must be assured at regional level for the provision of diagnostic reagents, supplies, and equipment. At national level, systems must exist for specimen collection and transport from original sites to laboratories.

3.2.3 Promoting the further development of applied research in the areas of rapid diagnosis, epidemiology and prevention

Under the category of applied research are included diagnostics, treatment, prevention, surveillance, development of products, and studies of socioeconomic factors affecting disease transmission.

Each country must determine its own emerging disease priority list. Obviously, the applied research needs will vary, depending on the diseases selected. In many countries, basic epidemiologic information about emerging diseases is still lacking. Research is needed on the prevalence, morbidity/mortality, geographic distribution, risk factors, and presence or absence of appropriate vectors and/or reservoirs, among others.

It is essential to standardize the clinical diagnosis and treatment of newly emerging diseases, and diagnostic protocols should be developed for the major emerging disease groups. Research is needed on the pathogenesis and spectrum of disease caused

by emerging agents. This should include acute as well as chronic disease manifestations.

Development of rapid and simple diagnostic techniques for emerging pathogens should have high priority. It would be useful to develop reagents (e.g., recombinant antigens and well-characterized monoclonal antibodies) which could be produced by a regional reference center or by local laboratories, depending on their capabilities.

There should be more field application of molecular epidemiologic techniques. On the other hand, some molecular techniques are not within the capability or budget of every laboratory. Studies of the cost effectiveness of various diagnostic tests should be carried out. There is often a tendency to develop the newest high-tech (molecular) diagnostic test when it may be more cost-effective to continue using a simpler and older test which gives the same information.

Antimicrobial resistance is a growing worldwide problem and a subject urgently needing research. Studies in this area should include the control of antibiotics in animal feed and fish/shrimp farms, testing of new drugs, and evaluation of therapies. Antimicrobial resistance should be studied in health care settings and in the community. It is important that the resulting information be disseminated from researchers to users in the community.

Food- and waterborne diseases are another important area for research. This should include studies of the economic, social, and behavioral factors affecting disease transmission.

Partnerships should be encouraged between investigators in different countries in developing applied research programs. In an era of reduced funding, sharing of resources and knowledge makes good sense.

Development of vaccines and other preventive strategies should have high priority in applied research programs. There should also be periodic evaluation of the cost-effectiveness of different preventive and control measures.

More research is needed on the effects of social, behavioral, and ecologic factors/changes on disease emergence. Research in this area should include the development and testing of innovative interventions to control or prevent emerging diseases.

In many countries, vector control programs now have low priority and are not very effective. Research is needed on alternative vector control strategies. This should include research on social and behavioral risk factors associated with disease risk prevention. There is a growing need for field-trained entomologists to study vector biology and behavior under field conditions.

3.2.4 *Strengthening the regional capacity for effective implementation of prevention and control strategies*

Consideration should be given to three broad areas related to prevention and control strategies for emerging diseases in the Americas:

- (a) *Information Dissemination:* This would consist of developing and regularly updating disease-specific prevention and control guidelines for communities and individuals, addressing both biologic and behavioral measures. Their development would require groups of experts for each disease as well as communications experts. Diseases of interest include, but are not limited to, yellow fever, dengue, antimicrobial resistant organisms (*P. falciparum*, *M. tuberculosis* and enteric bacteria), measles, polio, cholera and other food- and waterborne diseases, viral hemorrhagic fevers, plague, rabies and other zoonoses, trypanosomiasis and other vectorborne diseases. Points of contact to receive and transmit information in countries where action is taken should be properly identified, including organizations and individuals outside the government sector. In addition, in order to involve communities in the fight against emerging diseases, plans must be developed to distribute accurate and timely information for the education of the general public and the health community, making effective use of the press, including radio, television, newspapers, flyers, and other media.
- (b) *Antimicrobial resistance:* It is desirable to seek ways to reduce easy availability of over-the-counter antimicrobial agents, including veterinary applications. This would require efforts beyond the health care community, involving high-level interaction, education, and information dissemination to all sectors. Assistance to the countries in developing rational drug policies should be intensified. A very important aspect entails monitoring sensitivities to antibiotics in each country to allow for optimum selection of effective antibiotic use for individual cases and to eliminate antibiotics with little therapeutic value. Advantage should be taken of software presently available, such as WHONET and PHLIS. Other points to be considered include frequent revision and distribution of lists of essential antimicrobials based on sensitivity data and launching educational campaigns on cost-effectiveness of rational drug use in hospitals. Collaboration should be maintained with the pharmaceutical industry on rational drug use and on standardized labels and warnings, and ethical marketing strategies should be encouraged.
- (c) *Outbreak evaluation and control:* Several actions should be implemented in order to deal properly with epidemics. For example, for contingency situations it is necessary to develop or update guidelines that include: (i) timely recommendations to coordinate response to outbreaks or threats, including issues related to

travel advisories, quarantine, and commerce; (ii) policies and standard operating plans for response to outbreaks, at the regional and country levels; and (iii) lists of individuals and groups with disease-specific expertise, laboratories with disease-specific diagnostic capabilities, and products, such as diagnostic reagents, drugs, and vaccines (both licensed and investigational products). Most importantly, a system for rapid procurement of vaccines, reagents, insecticides and antimicrobials for prompt response to outbreaks should be available. Information management and dissemination procedures should be in place for use during outbreaks, including accurate and regular release of information to the press and public.

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