

## Global Infectious Disease Surveillance

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Infectious diseases remain the leading cause of death among children and young adults. They account for more than 13 million deaths a year with one in two deaths occurring in developing countries. Yet, as the battle to control known infectious diseases continues, new threats have emerged. Currently, researchers are challenged by the resurgence of epidemic diseases such as cholera, dengue, epidemic meningitis, and hemorrhagic fevers, as well as the devastating development of the human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) pandemic and other new diseases.

The propagation and transmission of infectious agents are favored in today's world, constituting health threats to all countries. The reasons include

- changes in the food industry that facilitate wide-spread dissemination of foodborne disease;
- migration and urbanization and the creation of peri-urban slums;
- human behavior, including sexual behavior that fosters sexually transmitted infections (STIs);
- environmental changes, including deforestation and changing agricultural practices as well as climate change, that have an impact on diseases such as malaria, cholera, and Rift Valley fever;
- emergence and spread of antimicrobial resistance, now of great public health concern worldwide, as many infections become increasingly difficult to treat;
- increasing volume and speed of international travel, increasing the potential for rapid international spread of disease.

These factors allow infectious diseases to spread rapidly; thus, it is critical to detect any new or unexpected outbreak. Effective global surveillance is essential to ensure that response is triggered without delay.

### IMPORTANCE OF GLOBAL SURVEILLANCE

Communicable disease surveillance provides the essential information to monitor, evaluate, and model the impact of prevention and control activities for endemic communicable and zoonotic diseases; to detect and track epidemic and emerging diseases and other public health threats, such as resistance to anti-infective drugs, and to geographically locate communicable diseases in countries, regions, and globally. At the national level, strengthened and integrated surveillance enables countries to identify populations at risk, implement prevention and control strategies, detect unusual disease patterns, and contain the re-emergence or emergence of communicable or zoonotic diseases.

Strong national surveillance is a core building block for effective global surveillance systems. Information from countries is required to guide international action and make the best use of scarce resources. Effective global surveillance depends on the quality of information from the countries. Global networks of laboratories and disease surveillance systems monitor specific communicable diseases and facilitate rapid information exchange on unusual disease events. Global and regional networks are needed to build the international preparedness and collaboration necessary for a coordinated response. With continuing globalization in travel and trade, global epidemic surveillance is essential to ensure international public health security. The key components of global epidemic surveillance are epidemic intelligence, coordination of epidemic response, and epidemic preparedness.

Successful global epidemic surveillance requires a nonpolitical approach and the capacity to facilitate collaboration between diverse partners. The World Health Organization (WHO), with its unique global health mandate from 191 Member States, is the appropriate organization to coordinate this effort. The Organization's multidisciplinary, problem-oriented teams together with its epidemic intelligence, preparedness, and response activities, have made it the natural focus for requests for advice and assistance on epidemic surveillance and response worldwide. The WHO recognizes the importance of its partners in global epidemic surveillance and strives to identify more effective ways of working with collaborating institutions.

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## **Epidemic Intelligence**

The WHO aims to strengthen national and international capacity in surveillance and control of communicable diseases, including timely detection and containment of outbreaks. An integral part of global epidemic surveillance, epidemic intelligence (accurate and timely information) about important disease outbreaks that may have international implications should be delivered systematically and rapidly to key professionals in international public health. This is being achieved through two mechanisms: global monitoring networks and outbreak verification.

### ***Global Monitoring Networks***

Unconfirmed reports of rumors of infectious disease events around the world are regularly received through WHO channels as well as from other sources (including nongovernmental organizations, the media and electronic discussion groups). Health Canada has developed the electronic Global Public Health Intelligence Network (GPHIN) in collaboration with the WHO to identify potentially high-impact, new, and unusual outbreaks. The GPHIN systematically scans the Web, particularly news media networks, news wires, and newspapers for outbreak-related information. The GPHIN provides information on a real-time basis that is used to analyze and assess the health risk of international events. The Internet technology platform used by the system enables the gathering of information about public health risks and its dissemination to end-users (e.g., WHO) for verification.

### ***Outbreak Verification***

To investigate and follow-up outbreak reports, the WHO established an innovative mechanism, outbreak verification, in early 1997. Outbreak verification aims to improve epidemic disease control by actively collecting and verifying information on reported outbreaks and informing key public health professionals about confirmed and unconfirmed outbreaks that are of potential international public health importance. The outbreak verification system follows the general principles of surveillance: systematic collection; collation, analysis, and interpretation of data; and dissemination to those who need the information for action.

When an unconfirmed outbreak report is received, the potential public health importance of the event is assessed on the basis of available background information, endemicity levels, and details of previous outbreaks. The outbreak verification team may seek additional information from other organizations in the field, such as the International Red Cross, Médecins sans Frontières, and Medical Emergency Relief International.

Whenever the outbreak verification team invokes a verification process, assistance to the affected country is

offered. Examples of such assistance include initial investigation of the outbreak on site, supply of essential materials to the outbreak site, transport of laboratory specimens from the field to appropriate diagnostic facilities, organization of vaccination programs, training of field staff as part of outbreak control measures, or deployment of field teams for disease control.

Over 500 outbreaks have been investigated in the past 2 years. Cholera, viral hemorrhagic fevers, and meningococcal meningitis comprised half of these events. Other outbreaks included plague, anthrax, viral encephalitis, dysentery, influenza, and relapsing fever. Virtually all countries experienced at least one outbreak. It is planned that this process will, in future, be applied directly at the regional level.

## **Epidemic Response**

When dealing with epidemics, the response of the international community needs to be coordinated. Three criteria are used to determine whether an international response is required:

1. Humanitarian: Does the country have the capacity to respond to an epidemic?
2. International spread: Does the disease have the potential to spread beyond national borders?
3. Travel and trade: Is there a risk that the epidemic may result in inappropriate international travel and trade restrictions?

The WHO plays an active role in the coordination of international epidemic response, and the number of requests to the WHO for technical and material support has increased significantly. Response can be in the form of investigating, verifying and disseminating information, coordinating response efforts in the field, or direct intervention in the field.

Examples of recent outbreaks during which WHO teams were in the field include: viral hemorrhagic fever in Afghanistan (2000); cholera in Madagascar (2000); Lassa fever and shigellosis in Sierra Leone (2000); Marburg virus infection in the Democratic Republic of the Congo (1999–2000); cholera in Somalia (1999–2000); influenza in Afghanistan (1999); relapsing fever in southern Sudan (1999); Rift Valley fever in Mauritania (1998–1999); avian influenza (H5N1) in Hong Kong, Special Administrative Region of China (1997–1998); and monkeypox in the Democratic Republic of the Congo (1996–1997).

Surveillance and response projects for emergency situations were undertaken in East Timor, Kosovo, and southern Sudan. Follow-up activities were then implemented in the areas of epidemiology training, laboratory strengthening, and information system development. Thus, an epidemic represents one of many entry points for the WHO

to become more deeply involved with an affected country, in the areas of epidemic preparedness and the development of more effective epidemic response.

### **Epidemic Preparedness**

The WHO works to improve global, regional, and national preparedness for epidemics by

- establishing global epidemic surveillance standards,
- creating networks of partners for preparedness and rapid response,
- strengthening laboratory capacity and laboratory networks,
- training in field epidemiology, and
- assessing and strengthening national surveillance systems.

Effective partnerships to strengthen surveillance and preparedness lead to an effective, timely response.

### **Global Surveillance Networks**

#### **Partnerships**

##### ***Cholera***

Nearly 120 countries have reported indigenous cases of cholera to the WHO since 1991, and nearly half of those countries have reported cholera for at least 5 of the past 8 years. Surveillance efforts show that the number of reported cases increased nearly 100% in 1998 compared to 1997, on all continents; thus, cholera is a recurring, growing problem in many areas.

In 1991, the WHO Global Task Force on Cholera Control was established to develop a more coordinated, more action-oriented approach to epidemic preparedness and control of this disease. Together with its partners on the task force, the WHO has developed an effective strategy to control cholera outbreaks and currently is considering the benefits of using oral vaccines in some specific public health settings.

##### ***Dengue-Dengue Hemorrhagic Fever***

The geographic distribution of dengue has greatly expanded, and the number of cases has increased dramatically in the past 30 years. It is now endemic in more than 100 countries in Asia and Latin America and threatens the health of about 40% of the world's population (2.5 billion people), particularly in tropical and subtropical regions and predominantly in urban and periurban areas. Over 1.2 million cases were reported to the WHO in 1998, the greatest number ever for a single year. There are an estimated 50 million infections annually, including 400,000 cases of dengue hemorrhagic fever (DHF), a potentially lethal complication first recognized during the 1950s and currently a leading cause of childhood

mortality in several Asian countries. The increase of dengue and DHF is attributable to uncontrolled population growth and urbanization in the absence of appropriate water management, to the global spread of dengue strains via travel and trade, and to the erosion of vector control programs.

Controlling dengue epidemics once they become established is difficult. Therefore, it is important to implement control measures when an increase in disease activity is first detected. This requires an effective disease surveillance program and intervention plan. Proactive surveillance systems that facilitate collection, referral, and testing of blood samples, and reporting and analysis of results, also can be used to predict outbreaks.

The WHO is embarking on new initiatives to strengthen global surveillance for dengue and response to outbreaks, to improve case management, and to develop an effective and safe dengue vaccine.

#### ***Influenza***

Since 1948, the WHO has developed and coordinated a global network for surveillance of influenza. The network gathers worldwide data on influenza activity. Detailed annual analysis of the circulating strains of influenza viruses provides the information on which WHO formulates recommendations to vaccine manufacturers for the composition of influenza vaccines for the following season in both the northern and southern hemispheres.

This global surveillance system comprises over 110 national influenza centers and four WHO collaborating centers where detailed analyses are carried out. An electronic database, FluNet, has been set up to allow countries to enter data on local virus isolates and to obtain information from other countries. Another product of the influenza program is the "Influenza Pandemic Preparedness Plan," which was published this year and is available on the Internet. The outbreak-response capacity on the influenza network was tested and shown to be effective in Hong Kong, Special Administrative Region of China, during the 1997-1998 avian influenza episode.

#### ***Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome***

The United Nations (UN) AIDS-WHO Working Group on Global HIV-AIDS and STI surveillance was established in 1997 to coordinate activities in this area. The group meets regularly to review HIV estimates. The activities carried out by the WHO are designed to develop national and international surveillance infrastructures, to ensure that information is available at global and local levels, to direct and evaluate prevention and control activities, and to stimulate research on new approaches to surveillance, prevention, and control.

Regional meetings are held with national HIV-AIDS epidemiologists and program managers to review surveillance activities, discuss improvements, analyze the present estimation methodologies, and draft plans of action and recommendations for future activities. A workshop on surveillance in hard-to-reach areas has been organized in collaboration with UNAIDS and the Robert Koch Institute (Berlin, Germany).

### ***Leishmaniasis-Human Immunodeficiency Virus Co-infection***

Leishmaniasis has been a long standing problem, affecting 350 million people in 88 countries around the world. A relatively recent development has been the emergence of leishmaniasis-HIV co-infection as a growing public health problem, resulting from the spread of leishmaniasis from rural to urban areas and the spread of HIV outward from the cities. The WHO, in partnership with UNAIDS, developed a new surveillance network to face this growing challenge, now involving 28 surveillance centers around the world. An electronic database was created and data analysis has been improved by mapping the cases using a geographic information system. Guidelines for the treatment of visceral leishmaniasis-HIV co-infections were produced and widely distributed.

### ***African Trypanosomiasis (Sleeping Sickness)***

Sleeping sickness was well-controlled earlier this century but has re-emerged over the past 30 years. It strikes remote rural areas south of the Sahara where health systems are either weak or nonexistent. Its spread is furthered by socioeconomic factors that prevent the establishment of public health initiatives (e.g., political instability, wars, and poverty).

Confronted with this resurgence, and facing a crisis in drug supply for this forgotten disease, the WHO has taken the lead in mobilizing and coordinating the activities of endemic countries and a wide range of partners. Surveillance demonstrated a pressing need for a continuing supply of drugs, and the WHO is working with the pharmaceutical industry, which has a unique role in combating this disease. An effective public-private sector partnership will ensure the availability and affordability of drugs to treat this orphan disease, which is invariably fatal without treatment.

### ***The International Coordinating Group on Vaccine Provision for Epidemic Meningitis Control***

The International Coordinating Group (ICG) on vaccine provision for epidemic meningitis control was set up in January 1997 in response to a crisis in vaccine supply for the control of severe epidemics of meningitis in Africa. The ICG strives to reduce the burden of epidemic

meningitis by ensuring the availability and rational distribution of emergency supplies of meningococcal serogroup A and C vaccine to countries experiencing epidemic meningococcal meningitis. As well as vaccine, the ICG ensures supplies of safe injection materials and antibiotic.

In addition to its central role in enabling an effective response to epidemics to be mounted, the ICG is now a working partnership that also deals with preparedness for epidemics and coordination of material and technical international support. The WHO provides the secretariat for the group, whose work is overseen by a subgroup of key international agencies: United Nations International Children's Emergency Fund (UNICEF), WHO, International Federation of the Red Cross and Red Crescent Societies (IFRC), and Médecins sans Frontières.

The severe epidemic in Sudan, with 33,216 cases and 2386 deaths, dominated the 1998-1999 meningitis season in Africa, and the ICG was involved in providing technical and material support to the government as well as supplies for mass immunization campaigns and treatment of cases. In 2000, the most severely affected countries have been Niger, Chad, Central African Republic, and Cameroon, with a continuing problem also in Southern Sudan.

### ***Resistance to Anti-infective Drugs***

Another approach to global networking is to take advantage of ongoing programs outside the WHO. Other networks exist, and they can be harnessed to contribute to a global resource. An example of this is antimicrobial-resistance monitoring, for which many programs exist throughout the world.

In 1999, the WHO established a new team to lead and expand its work on the surveillance and containment of resistance to anti-infectives. One of the strategies adopted by the group is to link the many existing antimicrobial-resistance (AR) monitoring networks to form a global network. Information on resistant organisms is now brought together in an electronic database, the AR InfoBank, which is now accessible on the Internet.

### ***Zoonoses and Foodborne Pathogens***

Many infectious agents that cause outbreaks of human disease are zoonotic pathogens transmitted from animals or from food of animal origin. There is a need for closer links between medical and veterinary public health authorities to recognize and control such outbreaks more effectively. The WHO is currently launching a new initiative on food safety, in which surveillance of foodborne pathogens and outbreaks is an important component. The consequences of the use of antibiotics as growth promoters in livestock are being evaluated as part of this effort, with a view to monitoring the emergence of

resistant organisms that threaten human health, and to advocate for the prudent use of antibiotics in animal husbandry.

### ***Rabies***

Rabies, one of the major zoonotic diseases, remains an important but underreported health problem in many developing countries. The WHO global rabies surveillance initiative (World Survey of Rabies) has been extended, and a Web version (RABNET) prepared. The database currently provides annual incidence and other data (e.g., status of surveillance, types of vaccines used) for over 140 countries for 1998. World surveys of human and animal rabies were carried out for 1997 and 1998, with data received from 137 countries.

The WHO is developing the "WHO Rabies Vaccine Initiative 2000." This initiative seeks to identify ways to overcome the current lack of affordable and safe rabies vaccines for humans in many rabies-infected areas and to prevent many of the estimated 60,000 annual deaths due to rabies.

### ***Global Network of World Health Organization Collaborating Centers***

Over 200 WHO collaborating centers worldwide deal with surveillance and response to communicable diseases. They comprise specialized laboratories or institutions with expertise in infectious diseases and cover a wide range of speciality areas. Many of the centers work on a particular disease or pathogen (e.g., meningococcal meningitis, influenza, or rabies), whereas others cover a wider range of diseases or pathogens that fall within a group (e.g., arboviruses), or cover areas such as antimicrobial resistance. The WHO is able to call upon experts in these centers of expertise all over the world, which are now linked electronically in an interactive network.

The centers regularly receive and analyze specimens and epidemiologic information from the country or countries that they serve. They work closely with the WHO to investigate, confirm, and control outbreaks of communicable diseases (e.g., during recent outbreaks of hemorrhagic fevers in Democratic Republic of the Congo, Kenya, and Sudan or of Nipah virus infection in Malaysia). They support global surveillance networks (influenza) and facilitate information exchange for global monitoring and control (antimicrobial resistance). Thus, these collaborating centers play a crucial role in the implementation of WHO activities.

### ***International Health Regulations***

Since 1948, the WHO has been responsible for the administration of the International Health Regulations (IHR), the only binding international public health legislation, which was ratified by its 190 Member States. The goal of

the IHR is to ensure maximum security against the international spread of diseases with minimum interference with world traffic and trade. These regulations are intended to strengthen the use of epidemiologic principles as applied internationally and to detect, reduce, or eliminate the sources from which infection spreads. They encourage epidemiologic activities at the national level so that there is little risk that an infection can spread from its country of origin to another country.

The current regulations, which date from 1969, apply only to cholera, plague, and yellow fever. Given the current trends in the epidemiology of communicable diseases and emerging disease threats, however, many other diseases can create international disturbance. To adapt to these new developments and to strengthen the global alert to outbreaks of potential international health importance, the regulations are currently being revised. It is proposed that under the revised regulations, any outbreak of urgent international importance will be notifiable.

### ***Importance of Surveillance at the National Level***

Currently, most surveillance activities are supported and managed by a variety of vertical disease control programs. Some are effective and linked to well-supported programs, whereas others have lost momentum, are poorly maintained, or have virtually collapsed. In some cases the surveillance function is far removed from any corresponding action such as disease control efforts, outbreak response, health resource allocation, or national health policy. Much of the work of the WHO in this area consists in helping countries to assess and strengthen their surveillance systems by encouraging a multidisease approach to make the best use of personnel and other available resources.

### ***Integrated Disease Surveillance and Response***

Effective communicable disease control relies on effective surveillance and response systems. Information on communicable diseases is a key part of public health decision-making in all countries. It is essential for priority setting, planning, resource mobilization and allocation, prediction and early detection of epidemics, and monitoring and evaluation of disease prevention and control programs. Disease surveillance is a critical component of health systems, providing essential information to ensure optimal health care delivery and cost-effective health strategies.

An integrated approach to communicable disease surveillance envisages all surveillance activities in a country as a common public service that carries out many functions, using similar structures, processes, and personnel. The surveillance activities that are well developed in one area may act as driving forces for strengthening other

surveillance activities, offering possible synergies and common resources.

The activities of the WHO are focussed on countries. Comprehensive assessments of national surveillance systems are carried out with the objective of building capacity within countries. The process brings together key decision-makers, strengthens communications networks, and fosters complete ownership of the process by the countries concerned. Nationals from both the public and private sectors are involved, as well as a range of partners, agencies, and institutions. National assessments have been carried out jointly with country staff of the United States Centers for Disease Control and Prevention (CDC) and United States Agency for International Development (USAID). The epidemiologic and laboratory capacity of a country is assessed in the light of current needs as defined by the priority diseases. After the field visits, a national plan of action is developed with short-, medium-, and long-term objectives, to address problems identified during the assessment, maximize synergies, and seek opportunities for integration. This is the starting point for a long-term obligation to which governments and communities must be committed. The success of national surveillance depends on political and financial support from the highest level. It is anticipated that an additional seven countries will conduct national surveillance systems assessments in 2000.

An integrated disease surveillance strategy for Africa was developed and endorsed by all Member States of the region, and activities using an integrated approach are now also under way in the other WHO-member regions. National surveillance plans are in preparation in a number of countries, including Egypt, Ethiopia, India, Lesotho, Madagascar, Malawi, and United Republic of Tanzania.

### ***Standard-setting and Data Collection and Analysis***

The work of the WHO in this area includes the preparation of surveillance guidelines, the elaboration of common terminology, and the setting of standards, in consultation with experts. In 1999, the second edition of WHO-recommended surveillance standards (covering over 40 diseases and syndromes) was finalized and published. A protocol for the assessment of national surveillance systems is being revised and field-tested.

A surveillance report prepared in 1999 brings together global information on several priority communicable diseases, notably data on cholera, plague, and yellow fever reported to the WHO between 1950 and 1999 under the International Health Regulations.

### ***Geographic Information Systems***

Spatial analysis and mapping in epidemiology have a long history, but until recently their use in public health has been limited. Maps have been either created man-

ually, or in research institutes using expensive computer equipment. However, recent advances in geographic information and mapping technologies have created new opportunities for public health administrators to enhance their planning, analysis, and monitoring capabilities. The late 1990s have seen a significant expansion in information and mapping technology, including the development of desktop mapping software, new programming tools for customization of mapping products and increasing connectivity to information highways such as the Web.

In a WHO-UNICEF joint program, a database management and mapping system, named HealthMap, has been developed and customized for public health applications at country, regional, and global levels. The system contains a standardized georeferenced database of country, regional, district and subdistrict boundary maps, rivers, roads, villages, and health and social infrastructures. Originally tested in West Africa, the system was extended in 1999 to cover an additional 10 countries: Cambodia, Egypt, Islamic Republic of Iran, Lao People's Democratic Republic, Myanmar, Thailand, Tunisia, Turkey, Vietnam, and Zimbabwe. HealthMap is now an important part of the WHO's Roll Back Malaria initiative.

## **CONCLUSION**

The WHO strives to ensure global public health security against infectious diseases through surveillance of infectious diseases and prompt and appropriate response to outbreaks. Through its global public health mandate, the Organization can play a special role in fostering effective links and partnerships to create an effective worldwide network, making the best use of expertise and resources, in the interest of world health.

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