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Preventing the Cross-Border Spread of Communicable Disease

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International Coordination to Control Communicable Disease – An Overview

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"Over the past two decades, explosive epidemics of unidentified and re-emerging diseases have given the world a few close calls. Some have affected international trade and tourism. Others have led to the mass slaughter of poultry and farm animals. Some have overwhelmed a country's health services and diverted resources from elsewhere. Almost all have caused fear and panic."

World Health Organization Report on Infectious Diseases: Removing Obstacles to Healthy Development. 1999

Introduction

We live in a world that has become a global village, with people moving readily and rapidly from one part of the world to another. People often transport their diseases, providing opportunities for the further spread of disease. If, however, a person has already been infected with a communicable disease before they depart from one part of the world, it is likely that they will arrive at their destination well within the incubation period (the time from infection to showing symptoms of disease) of many diseases. Gone are the days when prolonged sea voyages ensured that people before arriving in their destination country had mostly either recovered or died from an infection they had acquired prior to departure. Similarly, goods and vectors of disease such as animals or insects also move around the world. This means that we live with the potential for sharing diseases and their causal agents, and quarantine can not be effective. In our global village, everyone is a neighbor. National health has become indivisible from global health.

Infectious diseases cause morbidity and mortality in every country, and the recognition of emerging and re-emerging infections i.e. diseases that have increased or threatened to increase in the preceding two decades (Institute of Medicine, 1992), has highlighted the need for preparedness.

In the same way that people and disease are part of the global village, so too is the opportunity of controlling and preventing infectious diseases. Our challenge is to consider how best this can occur. What elements are needed to control infectious diseases? What are the success and the failure stories of recent years? What lessons can we learn as we come to terms with the realization that nationalism is insufficient to protect humans from infectious diseases but that the forces of globalization combined with contemporary technology may provide new opportunities for successful infectious disease control.

Basic principles of infectious diseases control mean that we require several areas of competence, whether the discussion is focused on local, national, regional or global infectious diseases control. Firstly we need surveillance, so we know what is going on; secondly we need the capacity to identify and respond to outbreaks; thirdly we need adequate knowledge and technology in diverse areas including laboratory, clinical, and epidemiological skills, fourthly we need good policy development and implementation including such diverse areas of relevance as the role of education, workforce development, communication and legal issues; and lastly we need the capacity to monitor and evaluate our actions.

In this chapter we consider the need for international coordination to control communicable disease. We ask why it is worth seeking better control of infectious diseases; consider the issues from an historical perspective including recent approaches to eradication, elimination and control; recognise the new challenges that face the world, and consider new strategies. We then consider what has worked and why, and what we need to do now.

Why it is worth ensuring better infectious diseases control

Good health is considered an important human value in its own right. When the arguments concerning the need for better international approaches to health are made, it is also important to articulate the reasons and benefits that can be factored into decisions. Most people involved in health delivery will assume that the inherent moral value of health is sufficient, however this viewpoint is not always shared by those outside the health sector. The costs of disease, rather than the contribution of health to our economies and the contribution of disease to a less healthy economy are often the focus of discussion about control of infectious diseases. All are relevant. The following section highlights some of the issues surrounding the arguments that improvements in infectious diseases control can benefit all.

Human impact

The impact of infectious diseases on people is enormous. Each year, of the nearly 54 million deaths worldwide, 25% (13.3 million) are caused by infectious diseases. In low income countries the proportion rises to 45% of all deaths. Infectious diseases are the major cause of deaths among children aged 0-4 years (63%) and cause 48% of all premature deaths, ie deaths occurring before the age of 45 years. Infectious diseases leave children without parents, wives destitute and unable to provide for their families, and husbands struggling to care for their motherless children.(WHO, 1999) The impact in

human terms extends far beyond the actual death. Better control of infectious diseases will decrease human misery and suffering, and lead to better and more fulfilling lives.

The financial impact of infectious diseases

Infectious diseases have financial impacts regardless of whether the disease is endemic or epidemic. Endemic disease costs have an impact on the finances of families, local areas, provinces, countries, and international alliances. All too often, the costs are not obvious but fall disproportionately on the least well-off people and countries, who are disproportionately at risk of infectious diseases. In addition, the costs associated with prevention and monitoring are rarely taken into account. For instance, the costs of border protection can be considerable and many countries spend large amounts of money on quarantine-related activities, inspections, monitoring and community education, but the se costs are unlikely to be attributed to any particular disease.

When any outbreak of disease occurs, it costs money, whether it is a local, national or international outbreak. For instance, even a small outbreak may be associated with people staying home from work for a day or two, leading to loss of wages and loss of productivity. Even a very minor episode can lead to loss of income for a business that, for example, provided food that is later found to have been the source of food poisoning. Such businesses may go out of business, leading to further unemployment.

The cost of many outbreaks is not known, but the costs of some elements of outbreaks can be seen in Table 1. All too often, routine health services are compromised when monies have to be diverted to outbreak control. The reality for most countries is that while the monies associated with controlling outbreaks are found, the real cost is the foregone opportunity to do something else with the money.

Table 1 Some examples of the cost of outbreaks

Outbreak	Some of the costs
Nipah Virus, Malaysia	105 deaths and approximately one million pigs destroyed Cost estimated ~ USD$395 million
Tuberculosis, New York City, 1980s	>USD$1 billion to obtain control
Cholera outbreak, Peru (WHO, 1999)	USD$770 million lost in exports from seafood, 1991
Plague (WHO, 1999)	USD$1.7 billion lost tourist income and trade, 1994
BSE, UK (1990-99)	Costs estimated at >$USD 9 billion
West Nile Virus, USA	Costs not available but estimated >USD$500 million

- *Some impacts of infectious diseases on economies*.[1]

Infectious diseases have major impacts on economies which can be a stimulus to developed countries and international organizations to assist in the control of disease. Some of the impacts are listed below.

- According to the World Health Organization, HIV prevalence rates of 10-15% – which are no longer uncommon – can translate into a reduction in growth rate of GDP per capita of up to 1% per year.
- Tuberculosis, which is made worse by HIV, takes an economic toll equivalent to $12 billion dollars from the incomes of poor communities.
- Africa's GDP would probably be about $100 billion more now if malaria had been tackled 30 years ago, when effective control measures first became available.
- The annual epidemics of influenza in developed countries represent uncounted millions of dollars in lost income due to illness or caring for persons both old and young with influenza.
- The global cost of hospital acquired infections is estimated to be USD$140 billion. (personal communication – Dr. John Connally, Canadian Hospital Epidemiology Committee)
- The cost of human-induced evolution in some diseases, ie the costs associated with drug-resitance are enormous; a few examples are shown in Table 2.

Table 2 Cost of human-induced evolution is some diseases

Factor	Cost (USD billion per year)
S. aureus, penicillin resistant	2 - 7
S. aureus, methicillin resistant	8
S. aureus, community acquired resistant	14 - 21
HIV drug resistance	6.3
Total	30.3 - 42.3

Source: Palumbi, SR, 2001

Improvements in health can provide substantial economic benefits.

As well as the negative impacts that infectious diseases have on health, it is also possible to estimate the benefits that derive from health interventions. For instance:

- Using data from 70 countries, the World Bank estimated that a decrease in under-five mortality of one percent is associated with a 1.24 percent increase in per capita income growth.
- Another study showed that improvements in male adult survival rates from 1965 to 1990 accounted for a large proportion of GDP growth and that the effect was particularly strong in poorer countries. In India and the Philippines, for instance, increased male adult survival accounted for 13 and 21 percent, respectively, of GDP growth during the period studied.

[1] These data are obtained from WHO, World Bank and Asia Development Bank websites

- Recent estimates indicate that the global eradication of polio will result in annual savings of USD$1.5 billion worldwide (including USD$230 million in the United States alone).
- In India, aggressive treatment of STDs could have reduced the number of new AIDS cases by about 50 percent. It was estimated that in the year 2000, this would have saved approximately USD$5 billion that would otherwise have been spent on the care of AIDS patients.
- In another example, a study from Indonesia demonstrated that treating helminth-associated iron deficiency anemia in children results in a 22 percent improvement in mental development and a 27 percent improvement in motor development as measured by standard tests.
- According to the World Health Organization, improved health in the Asian region accounted for fully one third of the economic boom that occurred from the 1960s to the end of the 80s.
- The United States estimates that the eradication of smallpox has resulted in a savings of $125 million every year in perpetuity.

How do the links between improvements in health and economic growth work?
(Asian Development Bank data).

- An increased share of working age population. As child health and access to family planning services improve, birth rates decline, people are available to work and this leads to a high ratio of working age to nonworking age population, and increases the per capita productive capacity. In East Asia, the working age population increased relative to dependents from the mid-1970s and this helps to explain that region's rapid economic growth.
- Improved health increases productivity. Healthy workers have more strength and endurance while working and a longer working life. In addition to being more productive, they take fewer days off due to illness, and the economic savings can be substantial. For example, a carefully controlled study in China showed that treating iron-deficient female factory workers improved their productivity by 17 percent. Similarly, the prevention of hepatitis B in Southeast Asia alone could potentially add USD$1 billion to national incomes through improved worker productivity at a cost of USD$41 million.
- Improved health increases the returns to education. The links between schooling and income are well established. Healthy children are better able to learn and take advantage of the investments made in their education.
- Good health conditions allow populations to take full advantage of other factors of production such as natural resources.

- Preventing disease frees up financial resources. For many illnesses, especially those that are expensive to treat, disease prevention offers a means of reducing the costs of curative care. The resources thereby freed up can be substantial.

There is good evidence that both endemic disease and disease outbreaks are associated with high costs, and that selective investing in health has good returns on such investment, and has the potential to benefit individuals, the country affected and has wider international benefits.

The inter-generational effect

The health of the mother while pregnant has an immediate effect on the fetus with, for instance, risks of premature delivery and low birthweight associated with infectious diseases. Recent research however has also shown the impact of events occurring in utero affect the life-long development of a range of diseases. Anything that affects e.g. nutrition and oxygenation during pregnancy may affect the resultant child for his/her whole life. There is good reason to prevent and control infectious diseases in order to provide the best opportunities for the next generation.

The historical perspective

The origins of today's complex system of international collaboration to control infectious diseases go back at least 600-700 years. Long before the discovery of microbes, city-states, geographic regions, and fledgling nation-states collaborated to control the spread of infectious diseases. In 1377, the City of Ragusa (now Dubrovnik) introduced a system of isolating ships coming from countries where plague was endemic. Presumably, word-of-mouth spread the news that neighboring towns or cities were experiencing outbreaks of illness and the imposition of limitations on entry into walled cities in the affected regions unknowingly contributed to halting the spread of disease. The practice of limiting entry became formally known as quarantine when the City-State of Venice established an isolation station (Lazaretto) and codified measures for isolation of ships for 40 days (hence *quarentenaria* , or quarantine). Although not well-recorded at the time, one may assume that the use of quarantine by neighboring cities might well have led to consultations and debates between neighboring cities about restrictions on trade and movement of people and the inappropriate use of quarantine. The end result could well have been coordination of the use of quarantine measures to calm angry merchants and the traveling public.

Several centuries passed before more formal attempts at international coordination to control international spread of infectious diseases occurred. The first of many meetings on the topic occurred

in 1851 at the First International Sanitary Conference in Paris in response to the threat of importation of plague into Europe. Since this meeting would establish uniform policies for the inspection and quarantine of ships arriving at European ports, the business community became very interested in health affairs. Multiple conferences[2] to exchange information on the occurrence of cholera, plague, yellow fever, among other diseases, and how best to control their spread took place between 1851 and 1938, in both Europe and the Americas. By the time of the 11th Conference in Paris in 1903, it was possible to attempt to control cholera, plague and yellow fever using scientific principles.

In 1907, delegates from 12 European nations met in Rome to establish a permanent international organization to execute the measures adopted by the international sanitary conferences. This agency became the Office International d'Hygiène Publique (OIHP), the first truly international health organization. For the next forty years, this institution conducted studies of epidemic diseases while hosting additional international sanitary conferences until the World Health Organization absorbed its functions.

In addition to refining some of the coordinated approaches to controlling the great epidemics of the times, these conferences laid the groundwork for international collaboration that resulted in two of the major institutions that exist today to join nations together to contain infectious diseases, the World Health Organization (WHO) and the Pan American Health Organization (PAHO, also the WHO Regional Office for the Americas). Conceptually, WHO can trace its origins back to the organization of the League of Nations following World War I. In the Covenant of the League, Article 23 provides that member states of the League "will endeavour to take steps in matters of international concern for the prevention and control of disease." An International Conference of Health Experts met in the same year (1920) that Europe faced epidemics of typhus, relapsing fever and cholera which were spreading from Russia into Eastern Europe. A temporary Epidemics Commission was set up to coordinate international efforts to deal with epidemics in Poland, Russia and the Baltic States. One approach was to organize a "sanitary cordon" following the Russo-Polish War when hundreds of thousands of refugees were driven into Central Russia and Siberia by the retreat of the Russian armies. It was learned that the efficacy of sanitary cordon (quarantine) measures depended on prompt and full notification of outbreaks and their course on both sides of the Russian-Polish frontier. Subsequent years saw the evolution and importance of national surveillance systems with international reporting of events of public health importance. Concern for surveillance and rapid notification persists today, 80 years later.

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[2] Second International Sanitary Conference, Paris, 1859; Third International Sanitary Congress, Constantinople, 1866;

In 1922, at the request of Poland, the League sanctioned an International Health Conference in Warsaw for 27 European countries. The Conference resulted in closer cooperation between Russia and Poland, with international training courses in anti-epidemic measures. The Epidemics Commission was active in Greece when advancing Turkish armies drove refugees from Asia Minor. Epidemics of smallpox, cholera and typhoid fever were devastating. Immunization campaigns were organized for over 550,000 people. In addition, the Commission began to publish reports of the health situation in Eastern Europe eventually expanding to compulsory notification of smallpox, dysentery, malaria, scarlet fever, diphtheria, etc. The first *Monthly Epidemiological Report* appeared in July 1923.

By 1923, a formal Health Committee, a precursor of the WHO concept, was established for the purpose of orchestrating international disease control efforts. It was composed of medical specialists, epidemiologists, statisticians and officials in charge of public health services from various countries in Europe, Latin America and the Far East. It became obvious to the Health Committee that, if they were co-coordinated, they would be able to investigate and hopefully understand the geographic and seasonal distribution of epidemics, the influence of climate, and other variables that might be amenable to control. The success of these efforts led Japan to examine epidemiological conditions in the Far East and the Eastern Epidemiological Intelligence Bureau was established in Singapore. This Bureau created a weekly telegraphic communication system involving 35 ports throughout Southeast Asia.

The Health Committee was also instrumental in promoting the standardization of statistical methods and data collection (e.g., causes of death and civil registries for death certificates) for international comparisons. Research was carried out through field investigations of epidemics of cholera in British India and Japan, cerebro-spinal meningitis in Prussia, morbidity and mortality of scarlet fever, as well as population-based surveys of diphtheria, smallpox, typhus, tularemia, polio and psittacosis.

One of the duties of the Health Committee was to establish closer relations between the administrative health authorities in the different countries. Frequent meetings provided opportunities for networking, profiting from each country's experiences and exchanging views on technical questions. The involvement of the non-governmental sector came in the form of support by the Rockefeller Foundation for traveling tours of experts to address particular issues and problems, e.g., tuberculosis, infant hygiene, school hygiene, health administration of ports, etc.

Fourth International Sanitary Congress, Vienna, 1874; etc.

The Committee was especially active in setting up a Malaria Commission to study malaria foci in Yugoslavia, Greece, Bulgaria, Rumania and Italy. Other Commissions were established to address African trypanosomiasis and tuberculosis. The latter involved collaboration with another non-governmental organization, the International Union Against Tuberculosis (now the International Union Against Tuberculosis and Lung Disease). By1928, the Committee was engaged in studies of the efficacy of BCG vaccination.

In the Americas, the 1870 epidemic of yellow fever in Brazil, Paraguay, Uruguay and Argentina occurred, in which 15,000 people died in Buenos Aires alone. This was followed by the spread of yellow fever through maritime contacts leading to outbreaks up and down the Mississippi River, led to the 1881 International Sanitary Conference in Washington, D.C. This Conference established an international system of notification of sanitary conditions in ports.

The work of Carlos Finlay elucidating the role of mosquito vectors in yellow fever, coupled with continued large-scale epidemics helped set the stage for the creation in 1902 of the oldest, continuously functioning international health agency in the world, the Pan American Sanitary Bureau (PASB). Eleven countries in the Americas met in Washington, D.C., to address common problems during the First International Sanitary Convention of the American Republics. Two years later, at the 1905 Convention, the vector and epidemic control successes of William Crawford Gorgas during the construction of the Panama Canal were reported. Multiple conventions every two years examined the health problems of the times, e.g., plague in Ecuador, Peru, Argentina and Chile, yellow fever, mostly in Brazil, typhus in Bolivia, Brazil, Chile, Mexico and the United States, undulant fever in the United States, onchocerciasis in Guatemala and Mexico, and malaria, tuberculosis, smallpox and polio in nearly all countries. By 1922, the *Boletin Panamericano de Sanidad* began to facilitate the exchange of epidemiological information between countries.

With the collapse of the League of Nations and the advent of World War II and its hundreds of thousands of refugees, the need for international collaboration to contain infectious diseases was addressed again under the umbrella of the new United Nations. Although United States and United Kingdom representatives to the April 1945 United Nations Conference had agreed that no questions in the field of health would be included on the agenda, the Chinese and Brazilian delegations proposed the establishment of a new international health organization. A declaration to establish what was to become the WHO was overwhelmingly supported. Subsequently, the WHO absorbed the work of the OIHP and the League of Nations and entered into a special

relationship with the PASB to establish the Pan American Health Organization (PAHO) as the WHO Regional Office for the Americas.

The WHO system and its allied institutions, including non-governmental organizations such as the International Union Against Tuberculosis and the International Union Against Venereal Diseases (now know as the International Union Against Sexually Transmitted Disease) rapidly became the focal point for coordinating international efforts to contain infectious diseases.

The WHO began in 1948, and today comprises 191 member states, divided into six regions of the world. Each Regional director and the Director-General are elected by the members and charged with being the focal point for health in either their region or the world. In recent years there has been increased recognition of partnerships with government and non-government sectors, links with the private sector and the need to facilitate global approaches to the challenges of infectious diseases.

Eradication, elimination and control: the optimism of the post-World War II period and the end of the 20th Century

The early years of WHO were marked by a period of international optimism. With the advent of effective antibiotics and new vaccines, the stage appeared to be set for the control and possible eradication or elimination of many infectious diseases.

There was cause for optimism at the beginning of the 1970s. In the Americas, by 1960, control of many infectious diseases resulted in an average five-year increase in life expectancy over the preceding decade in Argentina, Chile, El Salvador, Mexico and Venezuela. Death rates from infectious diseases were 41% lower in 1963 compared to 1956. Deaths due to malaria dropped from an annual average of 43,000 in 1950-52 to 2,300 in 1964. Smallpox was eliminated from the Western Hemisphere and no cases of urban yellow fever had been reported since 1954.

With the success of global smallpox eradication, WHO spawned new disease-specific international control efforts. The momentum and the enthusiasm led to some disease specific attempts at eradication but slowly gave way to realizations about the size of the task. As well, the increased understanding that only a relatively few diseases could be eliminated was daunting. In particular, there was recognition that the world's public health problems could not be solved by single disease solutions. What is clear, however, is that while eradication is limited in scope, it does have a powerful capacity in certain

circumstances. Generally, diseases have to be limited to humans and without a prolonged carrier period if eradication is to work. The following section describes both smallpox eradication and subsequent disease-specific control efforts.

Smallpox

Perhaps the greatest achievement in international collaboration was the Smallpox Eradication Program. By the beginning of the 20th century every continent and virtually every country in the world was affected by smallpox. As recently as 1967, some 10-15 million cases were still occurring annually in endemic countries while epidemics were common. Of these some two million died and millions of survivors were disfigured or blinded.

On January 1, 1967, the WHO launched the Intensified Smallpox Eradication Program using a strategy successfully implemented in Western Europe, North America, Japan and elsewhere.

The strategy was based on mass vaccination of entire populations. National governments favored such an approach because it provided a highly visible display of government action and substantial investments created an entire vaccination infrastructure. However, the goal of 100% vaccination proved untenable. Gradually a new strategy evolved, based on the lessons learned in Western Nigeria. In spite of 90% vaccination coverage, an epidemic occurred in a religious group refusing vaccination. When vaccine supplies to contain the outbreak were delayed, program staff employed rapid detection of sentinel cases with isolation and vaccination of the affected village. The new strategy of surveillance and containment evolved slowly and was accepted gradually, but time and again it was shown to be effective in breaking the chain of transmission. The process of institutional learning and local adaptation with international sharing of experiences was a key factor in the success of the program.

The development of heat stabile, freeze-dried vaccine, the jet injector and the bifurcated needle provided the appropriate tools to guarantee success.

WHO recognized the importance of flexibility and adaptation. Each national program was in part unique with its own administrative structures to adapt to local social and cultural conditions. Nevertheless, unambiguous performance standards and independent evaluations by international teams maintained the cohesion of the multi-national effort. When the last case was recorded, for the first time, a major infectious disease was totally eradicated through international collaboration that, although successful, was becoming more complex.

In 1977, the last naturally occurring case of smallpox was recorded in Somalia. The disease that claimed the lives of ancient kings and persons of all persuasions and socio-economic levels was defeated through a combination of multi-national commitments coupled with scientific advances.

The story of smallpox eradication became a template for the contributions that WHO could make, although it is not suitable for all diseases. Nonetheless, the story captured the imagination of decision-makers and the public throughout the world. The eradication of smallpox is unique. It epitomizes international collaboration with funding coming from the richer countries, helping poorer countries for the benefit of all. Of course, although it was less clear at the time, the eradication of smallpox was also cost-saving for developed countries.

At the same time it illustrated how countries could work together for the greater good of the world.

Lessons: Leadership, the involvement of relevant groups and people, a clearly articulated plan, the use of technology, the preparedness to be flexible in program delivery, and adaptation to local circumstances all contributed to the success of smallpox elimination.

Poliomyelitis

Polio with its associated crippling disability is a serious health threat to children. In 1988, the World Health Organization (WHO) resolved to eradicate polio worldwide by the year 2000. With the Expanded Programme for Immunization (EPI) in place and the precedent for the eradication of an infectious disease, WHO and its partners are optimistic about eradicating polio and certification of polio-free world in year 2005. Polio eradication appears to be one of the best developed of targeted goals even though the initiative requires substantial multilateral approaches as well as sufficient funds.

In 1985, the Pan American Health Organization (PAHO) initiated a formal campaign in the western hemisphere to eradicate polio in the Americas by the end of 1990. The PAHO built a successful program around a series of targeted victories against disease. The polio eradication effort was dominated by mass and repetitive immunization campaigns that permitted the Americas to achieve higher coverage with more doses of vaccine than was possible to achieve through routine immunization. The PAHO recorded the last endemic case of polio in 1991 and were certified by WHO as polio-free in 1994 (CAREC, 1999).

Inspired by the progress in the American region, the forty-first World Health Assembly (1988) called for global eradication of polio. Strategies adopted for the polio eradication program include the achievement and maintenance of high immunization levels, development of a standardized surveillance system to detect polio cases in a timely manner, assurance of vaccine quality control, availability of adequate laboratory services to all countries, adequate training and supervision of in-country personnel, social mobilization, provision of rehabilitation services for affected patients and additional research and development to maximize the effectiveness of polio vaccination (Patriarca and Sutter, 1992).

With the commitment of the WHO and its partners to the eradication program some strategies have been adopted to ensure worldwide eradication. The current strategies include high routine infant immunization coverage with OPV, national and sub-national immunization day programs, acute flaccid paralysis (AFP) surveillance and laboratory investigation, establish a network of laboratories to undertake virus isolation and identification of routes of transmission, and mop-up campaigns for the "containment" of the disease (WHO, 2000).

Routine immunization is the foundation of the eradication initiative. All countries aim to immunize at least 90 per cent of infants with four OPV doses by one year of age through routine immunization services. These doses are part of the basic immunization coverage recommended by the WHO EPI to protect children against major causes of morbidity in childhood. It is hoped that high routine immunization coverage decreases the incidence of polio and sets the stage for eradication.

National immunization day (NIDs) programs are one of the important initiatives aimed at eradicating polio through child vaccinations conducted on a national scale. NIDs are for interrupting wild poliovirus circulation in endemic countries. During NIDs all children aged less than five years in a country receive two doses of OPV one month apart, regardless of their prior immunization status. NIDs are needed for at least three consecutive years to interrupt transmission. NIDs are a strategy for interrupting wild poliovirus transmission; they are not a strategy for increasing routine immunization through campaigns. Donors on a coordinated basis have provided international aid for NID undertakings.

AFP surveillance is established in all polio-endemic or recently endemic countries to ensure that all cases of poliomyelitis are detected. The goal of AFP surveillance is to report and investigate "any case of acute flaccid (floppy) paralysis, and any case of suspected polio in persons of any age". A number of indicators have been established to monitor the performance of the AFP surveillance systems. For

example, an efficient AFP surveillance system should be to detect a case of AFP per 100 000 population, collect adequate stool specimens from at least 80 per cent of AFP cases, and test all specimen at a WHO-accredited laboratory (WHO, 2000).

A network of laboratories consisting of national laboratories (which undertake virus isolation and identification), regional reference laboratories (which differentiate wild and vaccine viruses), and specialized reference laboratories (which support the network and conduct genetic sequencing studies on wild viruses to assist the identification of routes of transmission) operate under the auspices of WHO. Laboratories involved in the network observe regular accreditation processes and there are established indicators to monitor their performance.

Mop-up campaigns aim to identify the final chains of wild poliovirus transmission in each geographical area. In these areas, two doses of OPV are administered to all children aged less than five years regardless of their prior immunization status, by immunization teams that go from house-to-house. These intensive immunization campaigns improve coverage and ensure that the most difficult-to-reach children are immunized, thereby interrupting the last chains of wild poliovirus transmission. In addition to delivering supplemental OPV doses, mop-up activities often include an active search for AFP cases.

WHO has established and maintained strong partnership with organizations, foundations, corporations and multilateral agencies who play important role such as coordination, fund raising, laboratory expertise, procurement and dissemination of vaccines and promotion of the initiative at both national and community levels. Some of the partners/current financial donors at the global level of the initiative are listed in Table 3.

Table 3: Some key partners in the polio eradication effort

Type of organization	Partners
Foundations	• Rotary Foundation • Bill and Melinda Gates Foundation • United Nations Foundation • Organization of the Petroleum Exporting Countries (OPEC) Foundation
Corporations	• Aventis Pasteur • De Beers • International Federation of Pharmaceutical Manufacturers Association (IFPMA) including Pasteur Mérieux Connaught (now Aventis Pasteur), Chiron, Smith-Kline Beecham, and Wyeth-Lederle.
Multilateral agencies	• European Union • World Bank

Non-governmental organizations (NGOs)	• International Red Cross • Red Crescent Movement • Médecins San Frontières (MSF) • Save the Children Fund • World Vision • CARE, etc.

This program illustrates the growing complexity of international collaboration involving WHO itself, UNICEF, USAID, the US Centers for Disease Control and Prevention (CDC), Rotary International, and the governments of Australia, Denmark, Japan, the United Kingdom and other countries. For the first time, the non-governmental voluntary sector assumed the responsibility of raising large sums of money to finance the purchase of polio vaccine. Rotary International will have raised over $400 million by the end of the campaign.

With respect to specific roles, the WHO is the lead partner in the polio eradication initiative. WHO, through its headquarters, regional, and country offices and infrastructure provides the overall technical direction and strategic planning for the management and coordination of the Global Polio Eradication Initiative. WHO is responsible for ensuring that all components of the strategic plan are technically sound and well implemented. The WHO also monitors and evaluates all aspects of the plan, coordinates the operational support of ministries of health, and trains as well as deploys human resources. In addition, WHO has a lead role in establishing certification standard, AFP surveillance (including the polio laboratory network), resource mobilization, donor coordination, advocacy, (e.g., for political commitment), and communication of information (WHO, 2000).

Rotary International has been the lead private sector partner in stimulating, developing and maintaining the Global Polio Eradication Initiative through its PolioPlus Program. The Rotary Foundation of Rotary International established the International PolioPlus Committee (IPPC) which develops strategies including global advocacy, fundraising, local club donations and volunteer support towards the polio eradication initiative. There are five regional and 65 national PolioPlus committees.

Rotary's Polio Eradication Advocacy Task Force has played a major role in motivating donor governments to contribute to the eradication efforts. The Task Force has a network of 23 national advocacy advisers based in donor countries. The advisers work with WHO and UNICEF to assist the task force in carrying the fundraising appeal to potential donor governments and the private sector. So far, Rotary International has contributed USD$407 million to the polio eradication

effort and Rotary estimates that its financial contributions will total USD$500 million by the end of 2005.

Rotarians at a local level work with clubs in polio endemic countries to provide specific on-the-ground assistance for polio immunization campaigns. These activities range from support for mobilization of materials such as posters, billboards, pamphlets and media announcements; to medical equipment such as containers for preserving and transporting vaccines; T-shirts and caps to identify health workers and volunteers; bicycles for volunteer transportation; and computers for enhanced surveillance communication.

The US Centers for Disease Control and Prevention (CDC) provides technical, laboratory, and programmatic assistance to the Global Polio Eradication Initiative. These activities are undertaken through the development of technical policies and plans of action and supports for implementation as well as evaluation of activities. Further, CDC provides support for the development of technologies, materials, and training for disease surveillance. It also conducts investigation of epidemics and epidemiological/operational/ laboratory research, provides funding for oral polio vaccine for supplementary immunization activities and long-term staff as well as participates in the development and monitoring of the laboratory network.

The United Nations Children Fund (UNICEF) is a lead partner in procurement and distribution of vaccine for routine and supplementary immunizations; implementation of intensified national immunization days, mop-up campaigns; and strengthening of routine immunization components of the strategic plan. UNICEF provides technical assistance to national coordinators in developing action plans and securing logistics to access hard-to-reach places, including countries in conflict. UNICEF also participates in the global process by which eradication policies and plans of action are developed; develops materials for training and public information; strengthens social mobilization efforts through its network of communications officers; and provides "cold chain" support for safe storage of vaccines.

Other key partners include governments of polio-endemic and recently endemic countries. These partners help to establish political and public commitment that is essential for the eradication initiative. Disease eradication efforts require a global response to provide adequate financial support to avoid interruptions which could reverse and complicate the goals of the eradication initiative. Donor governments play a central role through the provision of both bilateral and multilateral funds. Other international organizations such as the United Nations funds, agencies, and programs; foundations and corporations also support the polio eradication initiative at the global level.

Non-governmental organizations (NGOs) and humanitarian organizations are key partners, particularly through assisting with micro-planning, training, transport, surveillance and administration of supplementary immunization. Many NGOs play a unique role in accessing children in hard-to-reach areas, such as in conflict-affected countries.

Additional partner organizations play critical roles at the regional and country levels to support polio eradication. Of particular note is the Micronutrient Initiative of Canada whose support includes ensuring administration of vitamin A capsules during national immunization days and development of training materials. UN funds, agencies, and programs such as World Food Program, United Nations High Commissioner for Refugees, United Nations Office for the Coordination of Humanitarian Affairs and Operation Lifeline Sudan, have been key to implementing supplementary immunization activities. Specific activities of these partner organizations include participation at country, regional, and global levels, provision of financial and human resources, technical support and strategy implementation at country level through, for example, volunteers for social mobilization and NIDs, transportation and communications.

Civil society advocates and special ambassadors such as leading celebrities from the arts, sciences, entertainment, and sports field provide their personal talents to increase the profile of the eradication initiative. Key advocates for the polio eradication initiative include for example, UNICEF Special Representatives Ms Mia Farrow, Ms Claudia Schiffer, WHO Goodwill Ambassador Ms Martina Hingis, basketball star Mr Dikembe Mutombo, renowned photographer Lord Snowdon. Interagency committees are established to review financial resource requirements, coordinate the input of partner agencies and devise strategies for meeting the funding shortfalls (WHO, 2000).

Extraordinary progress has been made towards global polio eradication. By the end of 1999, thirty countries were considered to have poliovirus in circulation and by the end of 2000 the number of endemic countries was reduced to 20 and the number of polio cases had fallen by 95 per cent. The year 2005 is the target for certifying the world as polio-free. WHO Western Pacific Regional Office (WPRO) recorded the last endemic case of polio in 1997 and European Regional Office (EURO) in 1998 (ACIH, 2000).

In summary, polio eradication programs worldwide have been so successful to date that currently outbreaks of the disease appear to be limited almost exclusively to certain areas of Africa and Southwest Asia. Various factors including civil war, obstacles to the local delivery of vaccine supplies,

and unfavorable climatic conditions have impeded effective vaccination programs in the remaining endemic areas but efforts are underway to contain the situation. The challenges that must be overcome before the certification of polio-free world considering all other difficulties include securing access to all children, including those in conflict-affected countries, ensuring adequate financial resources from the public and private sector to meet the USD$450 million shortfall, and maintaining political commitment in both endemic and polio-free countries. With respect to the achievements made to date, it is necessary to continue the coordinated efforts until polio is eradicated completely.

Lessons: Polio eradication has benefited from leadership, flexibility and adaptation through a diversity of strategies, strong surveillance and laboratory capacity, adequate funding and many partners working towards a single goal.

Malaria

Early international efforts to control malaria built on the knowledge acquired by military medicine during WW II, such as the use of sulfanilamide to control wound infections, Atabrine for malaria prophylaxis and yellow fever vaccination and the discovery of DDT in 1942 and multiple new anti-malarial drugs, WHO launched the Malaria Eradication Program in 1955. Over the next 12 years until parasite and vector resistance to the measures used appeared, a major, worldwide coordinated multi-national effort eliminated malaria transmission from large geographic regions. Endemic malaria was successfully eradicated in multiple European countries (Hungary, Bulgaria, Romania, Yugoslavia, Spain, Poland, Italy, Netherlands and Portugal The US alone, through the U.S. Agency for International Development invested USD$790 million in the Global Eradication of Malaria Program.

Although the effort failed, the search for new strategies continues. Nearly half a century later, the global malaria situation remains bleak. Parasite resistance to each new anti-malarial is swift, while effective, low cost anti-vector measures remain elusive. Nearly 360 million people are exposed to the risk of *P. falciparum* and someone dies from malaria every 12 seconds. In reviewing the factors responsible for failure, it is worth noting how international politics influenced the effort. When WHO launched the program, it explicitly excluded sub-Saharan Africa, even though the 1950 Conference on Malaria Control in Equatorial Africa in Kampala endorsed the decision to control malaria. It was generally debated and finally accepted, without supporting data that finding an effective and economical method for eradicating malaria in Africa was not possible. International experts declared that Africa was "not ready."

Lessons: Not involving all who needed to be involved in a global collaboration appears to have been a major cause of the failure to control malaria, although the non-availability of modern technology and appropriate data may have been other major factors.

Today, most malaria deaths occur in Sub-Sahara Africa where malaria accounts for one in five of all childhood deaths. Globally, malaria kills over one million people a year (most of them children). Some of the recent partnership initiatives in the prevention and control of malaria include WHO's Roll Back Malaria and Medicines for Malaria Venture (MMV) programs. Through a global coalition involving UNDP, UNICEF, WHO and the World Bank, Roll Back Malaria is helping health systems to deliver cost-effective interventions including better health care, insecticide-treated bednets and improved environmental management. The Roll Back Malaria partnership provide assistance to all countries where malaria is a health problem with the greatest efforts directed to Africa where most malaria deaths occur.

The major goal of the new MMV program is to create a fund in support of the development of antimalarial drugs and drugs combinations for distribution in poor countries. It is expected that the MMV will help develop new drugs for malaria at a rate of one every five years. The MMV venture is a public-private sector initiative and partners include the World Bank, Global Forum for Health Research, The Rockefeller Foundation and the Wellcome Trust. Industry participants include the International Federation of Pharmaceutical Manufacturers Association and the Association of British Pharmaceutical Industries (WHO, 1999).

Lesson: The potential for success appears heightened by leadership, the involvement of relevant groups and people, involving both the private and public sectors as partners, and ensuring adequate funding as well as having a plan that includes a range of strategies.

Helminthic and parasitic disease eradication

Other diseases were targeted as appropriate tools for eradication were identified, including helminthic and parasitic disease eradication.

With the advent of effective vector control measures along with the donation of the drug ivermectin in an unprecedented collaboration by the private pharmaceutical sector (Merck and Company),

onchocerciasis (river blindness) in Africa has ceased to be a public health problem in 11 countries of West Africa.

Elimination of lymphatic filariasis is now a possibility with the donation by SmithKline Beecham of one of the drugs used in combination to treat 99% of cases effectively.

In the Southern Cone of South America, South American trypanosomiasis (Chagas' Disease) has been eliminated from Uruguay and large parts of Argentina and Paraguay. The vector elimination program is being extended in Bolivia and Peru.

The eradication of dracunculiasis (guinea worm) began in the early 80s, and to date the disease has been eliminated from India and Pakistan and is on the verge of elimination in other African countries, except where civil unrest has hampered progress. Unlike the vaccine preventable diseases, the eradication of dracunculiasis depends mainly on environmental and behavioral interventions that reduce exposure to contaminated water. Partners in the dracunculiasis eradication effort include the Carter Center's Global 2000 Program, UNICEF, WHO, and CDC the United Kingdom, Japan and OPEC Fund for International Development. Since 1986, the number of cases of dracunculiasis has decreased by 95% (WHO, 1997). The goals of the dracunculiasis eradication program are now directed at:

- implementing effective case containment measures in all endemic villages,
- establishing a community-based surveillance system in every known endemic village with monthly reporting of cases, supervision, and integration of surveillance for other major preventable diseases,
- targeting specific interventions (provision of safe water, health education, community mobilization, filter distribution, and treatment of selected water sources
- mapping all endemic villages and maintaining global and national dracunculiasis databases for monitoring of the epidemiological situation,
- sustaining advocacy for eradication of the disease, and
- certifying dracunculiasis eradication country by country world-wide.

CDC formally joined the eradication effort in 1984 when a WHO Collaborating Center for Research, Training, and Eradication of Guinea Worm was established at CDC's National Center for Infectious Diseases. CDC mapped the distribution of dracunculiasis and conducted research to improve its diagnosis, treatment, control, and prevention. CDC continues to send expert consultants to endemic countries to promote training and to provide support to national eradication programs (WHO, 1997).

In order to maintain the momentum towards eradication the World Health Assembly strongly urged all member states, international and non-governmental organizations and appropriate entities to continue to ensure political support and the availability of much-needed resources for completion of eradication of dracunculiasis as quickly as technically feasible (WHO, 1997).

Lessons: Appropriate collaborations of the affected people and groups, solid commitments by participating partners, diverse strategies planned for both the particular organism and the countries in which dracunculiasis occurs.

Leprosy

At the initiative of WHO, a Global Alliance for Leprosy Elimination was set up in 1999 with the aim of building on the experience of past leprosy control strategies to detect and cure all remaining leprosy cases from every country by 2005. The Alliance consists of the governments of leprosy-endemic countries, WHO, the International Federation of Anti-Leprosy Association (ILEP), the Nippon Foundation/Sasakawa Memorial Health Foundation and the Novartis Foundation for Sustainable Development. It also works closely with other agencies interested in leprosy control such as the Danish International Development Assistance (DANIDA) and the World Bank. National health ministries play a lead role in the elimination through development and implementation of strategic plans, coordinating the activities of the various partners and monitoring progress. WHO provides technical and strategic leadership to the elimination program as well as operational guidance. The Nippon Foundation has pledged US$24 million to implement the program and the Novartis Foundation for Sustainable Development is providing free MDT for all patients (valued at US$ 30 million). In addition to country level support the ILEP is providing extensive field network and it is financing many activities at the country level. DANIDA is supporting logistics in India and the World Bank is financing leprosy elimination efforts in India (WHO, 2001).

Lessons: Again, the success of leprosy control thus far reflects the importance of multiple partners with the same goals, adequate funding and appropriate and various strategies.

The challenges and wake up calls of our time

The new challenges for controlling infectious diseases facing the world are complex, reflecting changes in our cultural and social situations. They include the challenges of an increasing population which moves about more than ever before, the effects of globalization on travel and trade, and the ways in which we choose to run our societies. Such issues as emerging and re-

emerging infectious diseases, how we cope with the ever-increasing number of people with AIDS, the impact of new diseases such as variant Creutzfeldt Jacob Disease and the spectre of increased antibiotic resistance are all challenges for the world.

People on the move

As Tenzing Dorsok (not his real name) stepped off the bus in Toronto, Canada, in late December 1999, he became another illustration of the globalization of populations on the move and the absolute lack of respect that communicable diseases pay to the Canada-U.S. or any geographic border. Young and fairly well-educated, Tenzing had travelled thousands of miles from the other side of the world, moving from his native Tibet to southern India and then eventually to New York City. After spending almost a year in New York, Tenzing's long journey culminated in his claim for refugee status at the Fort Erie immigration office and then his transportation to Toronto. Unfortunately, like many of the hundreds of his fellow countrymen who had similarly made their way to Canada and applied for asylum in the previous year, Tenzing had unknowingly picked up an unwanted, hidden hitchhiker which would not be detected for weeks to come: an active tuberculosis infection that was resistant to multiple first-line drug treatments.

This episode demonstrates the rapid movement of people around the globe, and raises the premise that the geographic borders have lost any effective meaning when it comes to preventing the spread of disease and illness.

Each year, there are 670 million arrivals at multiple ports of entry around the world. The United Nations High Commission for Refugees reports 22.3 million displaced persons and about the same number of refugees. The World Trade Organization estimates that there are 10-15 million migrant workers.

The world's population is increasingly on the move. Immigrants seek economic opportunities in foreign countries; refugees and displaced peoples are forced to move across international borders while those who seek asylum use difficult or unorthodox means to gain access to foreign shores; foreign students seek educational opportunities outside of their home country; the number of tourists and short-term visitors continues to grow in both number and diversity; and migrant workers move to new employment opportunities in increasing numbers. The growing mobility of settled immigrants results in return visits to their countries of origin with increasing frequency.

Economic refugees from China are smuggled in on rusting ships and deposited on West Coast beaches of North America by unscrupulous traffickers in human beings. Others walk across the land borders. Many others arrive as tourists and promptly claim to be refugees from distant lands. Tourists may board cruise ships in New York City for a trip up the U.S. East Coast and down the St. Lawrence River

to view autumnal foliage with disembarkation in Montreal; in 1997, one such ship included tourists from Australia who generated an outbreak of influenza A on board. When the passengers disembarked, either in Montreal or in New York on the return trip, the A/Sydney strain of influenza was introduced into North America (Health Canada, 1998)

Long-staying arrivals from overseas, including refugees and foreign students, can introduce chronic infectious diseases of public health importance, such as drug-resistant tuberculosis. Shorter-term visitors can be the source of more acute infectious diseases, giving rise to concerns such as the risk of pandemic influenza that could become a major threat to the health of the public.

In a world with an increasingly mobile population, the infectious disease problems of arriving and returning populations will become an increasingly important concern for all nations. Over the past 25 years, there have been dramatic changes in the patterns of people on the move. People now migrate from different cultural backgrounds and places where their experiences, environment and exposure to infectious diseases differ markedly from disease patterns that are more common in developed nations. However, there have been no significant adjustments in government health policies in recognition of these changes. Policy and legislative tools are basically the same today as they were in 1950 with heavy dependence on quarantine and other measures to intercept communicable disease at the geographic border.

Trade and infectious diseases

It is not only the rapid movement of people around the world that calls into question the ability of borders to protect us from disease. One only has to look at how bovine spongiform encephalopathy (BSE or so-called "mad-cow disease") and foot-and-mouth disease have cut through the food and agricultural industries of Europe. These events would not have been possible unless food itself has become so globalized that the dining room table looks like a miniature United Nations of Brazilian corned beef, American cabbage, Italian spices and Australian wine for supper, topped off with a bowl of Guatemalan strawberries and English Devonshire cream for dessert.

To understand the enormous impact of trade consider the movement of agri-food products between Canada and the USA. Of the daily $1 billion in goods and services traded between Canada and the U.S., about $69 million a day is in agricultural products (Agriculture and Agri-Food Canada, 2001). Similarly, almost 61% of agri-food exports from Canada went to U.S. markets in 1999, some of which was re-exported to other countries; however, the U.S. spends less on Canadian foodstuffs than vice

versa as the per capita value of bilateral agri-food imports Canadians consumed was almost seven times that of the Americans (Agriculture and Agri-Food Canada, 2001).

While there is no doubt that the utmost attention is being paid to the safety of agricultural and agri-food products, the experience of European nations demonstrates how easy it is for disease to rapidly spread from one country to another once the first case occurs. There is no guarantee of immunity as disease organisms and vectors do not recognize imaginary boundaries on a map.

Emerging and re-emerging infectious diseases

In 1992, following the realization that an event such as the HIV pandemic could occur, the US Institute of Medicine published a landmark report about emerging and re-emerging diseases.(Institute of Medicine, 1992) This report catalogued the entire phenomenon of emerging and re-emerging infectious diseases, ranging from the growth and spread of antibiotic resistance to the emergence of newly discovered infectious agents.

In the last 20 years more than 30 new infectious diseases or organisms have been identified, including the rise of previously sensitive but now antibiotic-resistant organisms. In recent years, the world has witnessed the rise of diseases such as cholera 0139, E.coli 0157, Nipah virus, H5N1 influenza, West Nile Virus in the Western Hemisphere, hepatitis C, hantavirus, a resurgence of dengue and dengue hemorrhagic fever, the synergy between tuberculosis and HIV, to mention just a few.

The IOM Report examined many factors that have contributed to the rise in emerging and re-emerging infections and these are listed in Table 4.

Table 4 Modern demographic and environmental conditions that favor the spread of infectious diseases

- Global travel.
- Globalization of the food supply and centralized processing of food.
- Population growth and increased urbanization and crowding.
- Population movements due to civil wars, famines, and other human-caused or natural disasters.
- Irrigation, deforestation, and reforestation projects that alter the habitats of disease carrying insects and animals.
- Human behaviors such as intravenous drug use and risky sexual behavior.
- Increased use of antimicrobial agents and pesticides, hastening the development of resistance.
- Increased human contact with tropical rain forests and other wilderness habitats that are reservoirs for insects and animals that harbor unknown infectious agents.

There are many examples of emerging and re-emerging infectious diseases however in the following section just AIDS and BSE/CJD are described.

The Human Immunodeficiency Virus and AIDS

In June 1981, the general optimism surrounding the control of infectious diseases was shattered by the discovery of what ultimately became the Human Immunodeficiency Virus (HIV) pandemic. A completely new virus was able to disseminate itself widely through out the world as a sexually transmitted and blood-borne disease. It is another good example of how close our world has become. Twenty five years ago we had never heard about HIV, yet now HIV has occurred in every country in the world. The prevalence in some African countries is as high as 25%. The cost of treating HIV has remained outside the capacity of many countries to pay for even the most basic treatment, never mind treatment for opportunistic infections or the more expensive life-saving anti-retroviral drugs.

In many ways, the HIV epidemic epitomizes the issues in globalization of diseases. The virus has spread internationally and rapidly. It has major impacts on all aspects of society. It is in everyone's interests to control the spread yet many countries still fail to acknowledge the extent of the problem. Resource-poor countries need considerable assistance from richer countries to ensure that they have access to surveillance, prevention programs, treatment and care for ill people and monitoring and evaluation of programs. The US, Europe and Australia are witnessing falls in mortality with the availability of combination therapies however in much of the world, the epidemic continues to worsen. The issues are complex, and remain a challenge to the whole of the world. A considerable amount of bilateral and multilateral funds have been expended on prevention however there are already over 36 million people with HIV who need treatment and care. Even with prevention, in the developing world there are few countries that have recorded falls in new cases. Two countries that have recorded a decreasing incidence are Thailand and Cambodia.

Partnership in the control and prevention of HIV/AIDS in some of the world's poor areas such as Africa is vital for global control of the disease. United Nations organizations are coordinating the global response and providing program and financial support to country-level efforts. As an intensified response African countries together with the UNAIDS, bilateral development agencies, NGOs, and the private sector are building an International Partnership against AIDS in Africa. Their goal is to help reduce the number of new HIV infections, promote care for those who suffer

from the virus, and mobilize society to prevent the spread of AIDS. Vaccines are still at the developmental stage.

By providing national leadership, African governments are lead partners in broad-based international responses. Donor governments are also supporting action at all levels, providing input and financial assistance into substantive development of the partnership. The private sector is providing expertise and resources. And, finally, the community sector is working to ensure ownership of the partnership within local society and to strengthen regional and country networks (UNAIDS, 2001).

Bovine Spongiform Encephalopathy (BSE) and variant Creutzfeldt Jacob Disease (vCJD)

The massive BSE outbreak in cows in the United Kingdom has been linked to a subsequent human outbreak of a disease that has been called variant CJD (vCJD). It is thought that BSE in cows was initially acquired from the sheep scrapie agent from feed supplements derived from the rendered carcasses of farm animals, and subsequently spread by the practice of feeding beef bonemeal to other cattle. These feed supplements were fed to cows in the 1970s and 1980s in the UK. vCJD is thought to have been caused by the human consumption of infected beef.

Even though relatively few people have presented with vCJD, it has received a great deal of attention in recent years because of the association with BSE. Although the first cases of BSE are now thought to have occurred in the 1970s, it was not until late 1984 that a cow was diagnosed with a spongiform encephalopathy in the United Kingdom. This was followed by a huge number of cases. In 1988, cattle brains and other offal were banned from cattle feed and BSE was made a notifiable disease of cattle in the UK. Later the same year, government authorities officially recognised that BSE was a disease that could be passed from animals to humans. In 1989, the British Government banned human consumption of brain, spinal cord, spleen, thymus and intestines from cattle. In 1992 the number of BSE cases peaked with three cows in every thousand infected in the UK. In the subsequent years, the outbreak spread to continental Europe and Eire, with hundreds of cases in such countries as France, Germany, Portugal, and Switzerland.

In 1995 the first identified case of vCJD, died, and the deaths of three dairy farmers prompted the UK CJD surveillance unit to express concern over high incidence of CJD in farmers.

In 1996 it was announced to the British parliament that 10 young people were believed to have been infected by vCJD after eating BSE infected beef before the offal ban in 1989. This eventually became called new variant CJD and later, variant CJD. vCJD was linked with beef consumption and a rise in the diagnoses of bovine spongiform encephalopathy in cattle.

As a result of this, the UK ordered the removal of all cattle over 30 months in age from the human food chain, as well as modifications to the processes of butchering cattle to ensure central nervous system material was not being consumed by humans. The UK has also recently ordered the compulsory slaughter of scrapie-infected sheep, as well as the banning of human consumption of the heads and spleens of sheep of any age, and the spinal cords of sheep over one year old. In total, over 180,000 cattle have been diagnosed with BSE in the UK.

We already know that probable infected bone meal was shipped into parts of Asia, and we already know that infections in either cattle or humans may pass un-noticed and un-investigated. No real global effort has been made to control the spread of BSE and ensure that prions, the transmissible agent, do not become established in the food chain.

Lessons: the advent of BSE and CJD highlights the difficulties of being aware of previously un-described diseases. Perhaps more importantly it highlights that control efforts should have an international approach. In this instance it appears that the effective primacy of trade over health led to contaminated material that was not considered fit for use in one country being exported to others. This has also highlighted the pressures that short term financial drivers can cause even though the long term costs are likely to be far greater. It also highlights the dominance of local issues and demands in outbreak situations, rather than the international requirements.

There *are* diseases out there that threaten us. Some have come in the face of apathy, or at least because we were not proactive. We need to be much more pro-active in ensuring that this risk is minimised. Controlling disease in one country may help control disease in others. But countries have to know they have diseases and have the capacity to identify, investigate and control such diseases. Moreover, controlling the diseases that we already have is the best preparation for controlling the diseases that are yet to emerge.

New strategies for contemporary problems

There are many new strategies being undertaken to prevent or control communicable diseases, the challenge is how to ensure such strategies become, where appropriate, part of routine practice. These strategies include disease specific approaches that can suggest ways of controlling the same disease in different places, or suggest strategies to control other diseases. There are also technical and organisational strategies that can facilitate communicable disease control.

The approach to different diseases

Immunisation

Immunization is one of the most cost-effective interventions available to deliver health to many people, especially to children in the poorest regions of world (Melgaard, 1999). The Expanded Program on Immunization (EPI) and the Control of Diarrheal Diseases Program (CDD) took scientific advances (e.g., cold chain maintenance and oral rehydration salts) and promoted the organization of specific targeted programs with their own administrative structures in WHO member countries. Both programs were very successful in reducing morbidity and mortality while interrupting the chain of transmission of childhood vaccine preventable diseases.

Early national immunization programs occurred between 1900 and 1973. As vaccines proved to be highly efficient in reducing the burden of death and diseases from infectious microbes their use was widespread in industrialized countries but delivered in a haphazard manner. For example, smallpox vaccine was offered to all age groups but administered only to those considered at risk (WHO, 2001b).

A large-scale immunization program to eliminate measles occurred in the Gambia from 1967 to 1970. The program was successful and indigenous measles was eliminated in the Gambia in 1972 but the success of the program was short lived and the situation was reversed to the pre-campaign level(Foege, 1971). Measles returned to the Gambia because the immunization program was not sustained and there were pockets of potential infected sources surrounding the country (WHO, 2001).

Lessons: This is an example where national control was obtained but could not be sustained in the absence of strategies to control measles in nearby countries.

The Expanded Program on Immunization

After the impressive results of the smallpox eradication, the WHO took another initiative and launched the Expanded Program on Immunization (EPI) in 1974. The immunization effort was identified as

"Expanded" because most programs until then had only used smallpox, BCG and diphtheria, tetanus and pertussis (DPT) vaccines but the EPI included more diseases. The six diseases included at the time the EPI was launched include measles, diphtheria, pertussis, tetanus, tuberculosis and poliomyelitis. Four other diseases have since been recommended for the EPI program and these include yellow fever in 1988 (Africa only), hepatitis B in 1992, Hib in 1997 and Japanese encephalitis in 1998 (endemic areas) (Mansoor, 1999). The EPI also meant increased coverage because less than five per cent of children were being reached at that time by immunization services (WHO, 2001). The goal of the EPI is to achieve universal child immunization and the achievements of the program since its establishment are shown in Table 5.

It costs about USD$10-15 to immunize a child with vaccines currently used in the EPI program. With more than 100 million children born each year in the developing world, that means it will cost about USD$1.4 billion a year to fully immunize all these children. Under the current program, developing countries in which the immunization programs are operating provide about two-thirds of the funding, with the remainder coming from donors (CPHA, 2001).

Activities of the EPI partners (including WHO, UNICEF, other United Nation's agencies, bilateral development agencies, governments, and non-governmental organizations) contribute towards disease prevention, control and eradication by improving the quality and quantity of vaccination, minimizing financial burdens for needy people, increasing community participation, improve monitoring of disease and vaccination, developing new or improved vaccines and improving vaccine use (CPHA, 2001).

Since 1990, there has been a sense that efforts to improve immunization coverage on a global basis have been stagnating. Some of the necessary factors identified to reinvigorate the EPI for the 21st century include: timeliness for the introduction of new vaccines, reinforced routine immunization, maintenance of effective EPI programs within the context of health reform, and maintaining adequate and sustainable financing mechanisms for both vaccine procurement and for the financing of the delivery system. There is a call for partnership to support strategies that will ensure the introduction of new vaccines to needy children in the developing world as soon as they are licensed and or introduced to children in the developed world. A strategy based on waiting to recover investment from the introduction of new vaccines from the private sector in the developed world is considered unacceptable. In addition to outreach programs such as national immunization days utilizing mass immunization of children irrespective of their immunization record, effective routine delivery of existing and new vaccines are considered as the bedrock of a newly reinvigorated EPI in the 21st century.

Health reforms in many developing countries emphasized decentralization but this concept may have adversely affected some elements of national immunization programs. Procurement and quality assurance of vaccines are some of the activities that are badly affected because local authorities at the district or provincial levels in many countries can not meet their responsibilities. It is envisaged that through partnership economic reform policy packages could be tailored to promote global issues such as immunization. Funding is one of the important reasons for promoting bilateral and multilateral agency partnership for global immunization programs such as the EPI.

The remarkable ability of the EPI to deliver vaccines in developing country settings is demonstrated by high levels of coverage. Although some gaps in immunization coverage still exist (for example in measles coverage in Africa and in the limited ability to reach women of child bearing age with tetanus vaccine), immunization coverage is as high in developing countries as it is in developed countries (Wright, 1995). At the 1990 coverage level, it was estimated that about 3.2 million deaths are prevented each year. However, nearly two million children still die annually from these diseases (CPHA, 2001).

The EPI has also been drawn into close collaboration with other WHO preventive and therapeutic endeavors such as the oral rehydration efforts of the program for control of diarrhoeal diseases and the distribution of supplemental iodine and vitamin A and other issues of child health including nutrition and breast-feeding. The schedule vaccination visits are used in most countries as the framework around which preventive pediatric care is delivered in the first two years of life (Wright, 1995)

Although the EPI has maintained an enviable reputation throughout the developing world the program has challenges as well. Basically, immunization policy had to be developed at the global level by EPI and at the individual level by Ministries of Health. The program started from a minimal base with few sources of vaccine of documented quality and little infrastructure for the delivery of vaccines under appropriate storage conditions. Since there was and is little refrigeration or reliable electrical power in most places there was a need to establish and maintain a "cold chain" for safe vaccine delivery. There was an initial and an ongoing need to obtain political and local support for the program. Further people had to be trained in immunization practices including sterilization and injection techniques. There was need to establish immunization schedules and networks of immunization clinics that made vaccines accessible. In order to monitor the success of the program in terms of doses of vaccine used, adverse effects, and success attributable to immunization there was a need to establish surveillance systems. With the coordinated support of all partners the EPI has been able to overcome most of these impediment and maintained a healthy immunization program in the developing world (Wright, 1995).

An example of EPI working across national borders to control vaccine-preventable diseases is seen in the Caribbean.

The EPI was started in the early 1970s in the Caribbean region. The Caribbean Epidemiology Center (CAREC) with the PAHO coordinates the regional program. Since the start of the EPI measles and poliomyelitis have been eliminated from the countries of the Caribbean Community. The vaccines are primarily administered under a public sector infant immunization scheme through a network of clinics. In most countries the vaccines used in the private sector are provided by the public sector. Most countries had an adequate supply of vaccines, syringes and needles in 1999. Over 90% of countries have been purchasing their public sector vaccines through the PAHO/EPI Revolving Fund. This fund is also the source of some of the vaccines used by many of the practitioners in the private sector. Whenever there is a shortage of a particular type of vaccine in some countries others willingly share vaccines in order to minimize the interruption of the program.

The EPI was considered as a success in the Caribbean region and in the Americas. The average coverage rate for all 19 countries in the region in 1999 were – (DPT) 88%, (OPV) 88%, (MMR) 88% and (BCG) 89 %. The coverage figures for the countries range from 82% to 100%. Currently, member countries are increasingly introducing Haemophilus influenzae type B (Hib) and hepatitis B vaccines in their public sector infant immunization schedules (CAREC, 1999). A CAREC coordinated surveillance program in the region enhanced the disease control efforts. All countries submit weekly national reports to the CAREC.

Lessons from EPI: targeted programs, leadership, bilateral and multilateral sharing of resources including appropriate funding, and the working together of a large and diverse group of partners have contributed to the ongoing and (thus far) sustained success of the EPI program.

Table 5: Milestones of the expanded program on immunization

1974	Expanded Program on Immunization (EPI) established by the World Health Assembly of the World Health Organization (WHO).
1975	Immunization coverage in the developing world estimated at less than five per cent
1977	The World Health Assembly approves the goal of immunization for all children of the world.
1982	UNICEF launches “Child Survival and Development Revolution” which focuses UNICEF support on immunization activities.
1984	Immunization coverage estimated at 25 per cent

1985	Rotary International "Polio Plus" program launched.
1986	Immunization coverage reaches 50 per cent.
1987	The World Health Assembly establishes disease reduction targets for the EPI: eradication of poliomyelitis, elimination of tetanus, reduction of measles.
1989	Immunization coverage reaches 75 per cent.
1989	The United Nations General Assembly adopts convention on the Rights of the Child.
1990	UNICEF buys more than one billion doses of vaccine for the first time. BCG, DPI, Poliomyelitis and measles reach UCI goals of 80 per cent coverage or more.
1994	Certification of the eradication of polio in the Americas by the Pan American Health Organization.
2000	Certification of the eradication of polio in the Western Pacific Region of the World Health Organization

The Global Alliance for Vaccines and Immunization

In order to further improve the effectiveness of immunization services worldwide, WHO and UNICEF together with other partners established The Global Alliance for Vaccines and Immunization (GAVI) in 1999. The coalition of partners include the World Bank, the Bill and Melinda Gates Children's Vaccines Program, the Canadian International Development Agency (CIDA), the Japanese International Cooperation Agency (JICA), the United States Agency for International Development (USAID), the United States Centers for Disease Control and Prevention (CDC), the industry and several national and international professional organizations (WHO, 1999).

The strategic objectives of GAVI are to increase and sustain routine immunization coverage; to introduce under-utilized vaccines, initially against cancer causing hepatitis B, meningitis and pneumonia causing *Haemophilus influenza* b, and yellow fever; to stimulate research and development of new vaccines important for developing countries; and to use immunization coverage as one of the indicators to measure progress of development programs in reducing poverty. The GAVI also aims at establishing a comprehensive system to ensure the safety of all vaccines given in national immunization programmes by the year 2003 (UNICEF, 2001).

It is too early to know whether GAVI will be successful or not**;** GAVI, however includes many of the elements that could predict success ie leadership, multiple partners, clear objectives and the capacity to provide appropriate funding.

Broadly, the success of immunization could be seen as depending on such elements as political commitment, international partnerships, surveillance capacity, response capacity, ensuring appropriate policy responses and the capacity to monitor activities. Strong political support is necessary for the

promotion as well as financing of the immunization agenda. Lessons learned from the ongoing immunization programs indicate that global alliance of bilateral donors and multilateral agencies are vital and improve delivery of immunization services even under difficult circumstances. Adequate surveillance system and diagnostic capacity are necessary to support any disease control strategy.

Tuberculosis

TB was once thought to be under control but has re-emerged with disastrous effects killing about 1.5 million people a year and even more when in combination with HIV/AIDS. Nearly two billion people (one third of the world's population) have latent TB infection. TB is a leading cause of death among women and it kills more adolescents and adults than any single infection. The rise in tuberculosis rates around the world have occurred for multiple reasons including the failure of public health services, the association with HIV/AIDS, the rise in multidrug resistance and the effects of people movement. Tuberculosis control programs began to contain TB-related morbidity and mortality while utilizing increasingly patient-friendly treatment regimens throughout the 1960s and 70s.

The WHO has launched the STOP TB initiative to control the disease. The STOP TB initiative is a partnership of countries with serious TB problems, UN, and other international organizations, bilateral donors, scientific and public health institutions and NGOs. The initiative is promoting the use of cost-effective Directly Observed Treatment, Short-course (DOTS) in all countries, but especially those with serious TB problems. The partnership aims at ending social apathy towards TB, expanding the global coalition of partners involved in the TB control, pushing TB issues higher on both international and national health agenda, and increasing investment in DOTS (WHO, 1999). In addition, WHO and the global partnership to STOP TB formally launched the Global TB Drug Facility (GDF) in March 2001. The GDF is expected to increase access to high quality TB drugs and will treat 10 million TB patients over the next five years (Lee, 2001).

Many non-government organizations have concentrated on increasing the capacity within-country to deal with TB.

Lessons: Tuberculosis control highlights the importance of maintenance of public health capacity and skills. STOP-TB represents multiple partners, dedicated funding and strategic planning.

Using bilateral approaches to capacity building efforts in AIDS

There are ongoing efforts globally to halt the HIV/AIDS pandemic. Regional efforts as well as bilateral and multilateral projects can enhance capacity to prevent and treat HIV/AIDS. Some of these projects are briefly discussed.

Caribbean HIV/AIDS Project

The Caribbean Epidemiology Center (CAREC) through the Pan American Health Organization (PAHO) implemented a regional project to reduce the spread of HIV/AIDS, STD and TB and minimize the impact on the health and well-being of individuals and communities in member countries. The Canadian Public Health Association (CPHA) through the Canadian International Development Agency supported this regional project by providing technical partnership to the PAHO/CAREC. The CPHA essentially identifies appropriate Canadian technical expertise and provides advice and guidance particularly in the area of health promotion, HIV/AIDS counseling, care and support, disease surveillance, laboratory diagnostic and management quality assurance and quality control, strategic planning, project management and monitoring, institutional; capacity building and sustainability, and the role of the media in HIV/AIDS. This project targets member country Ministries of Health as well as NGOs and community-based organizations that address the needs of women, youth and people living with HIV and AIDS.

Southern African AIDS Training (SAT) Program, Phase II

The SAT funded by the Canadian International Development Agency (CIDA) is a regional/bilateral program in its second five-year phase (1996-2001). The SAT program goal is to contribute to community-based responses to the HIV/AIDS epidemic in Southern African countries. The SAT has been working to support eleven Southern African countries through financial support, project management and training support to over 500 projects with 120 plus partner community organizations working at the frontline of the epidemic. The program purpose is to improve partner service delivery capacity by providing inputs to assist partner organizations develop the methods and skills needed to support effective community-based programs. SAT promotes results-oriented program activities and results achieved are grouped into three thematic areas namely; HIV prevention, AIDS initiative through care and support and gender and human rights advocacy.

Prevention of HIV and sexually transmitted infection activities include community outreach, utilizing participatory methods; private and public sector workplace prevention programs; one-to-one information giving; preventive counseling; provision of intensive reproductive education services for

women; and targeted condom distribution for groups involved in high risk sexual activity; prevention and monitoring.

Advocacy for social change is aimed at reducing social vulnerability to HIV and AIDS. Program activities include the identification of abuses of child, human or gender rights; challenging abuses through community-based advocacy; provision of crisis support; counseling; legal advice and information services; program modeling on gender rights; and practical training on the human and child rights framework applicable to HIV and reproductive health advocacy.

The SAT program is replicated and multiplied in the Southern African region through a novel "learning by seeing and doing: approaches called the School Without Walls (SWW). Through the SWW experienced SAT partners train and mentor less experienced ones, passing on tested methods and systems. The SWW is not a conventional "train-the trainer" approach. Its aim is to transfer or replicate successful programs, methods, and outcomes from one organization to another. The training is conducted in small groups on actual project sites, involves practical exercises and problem solving, incorporates participation in real project activities, and is followed up with monitoring and apprenticeship visits.

Romanian Adolescent Health, HIV/AIDS Prevention and Social Services Project.

This project aims at strengthening the national response to HIV/AIDS and particularly Romania's HIV/AIDS prevention and control strategy for adolescents. The project pursues a comprehensive strategy to address the critical inter-related areas of national planning and coordination, HIV/AIDS awareness raising, information, education and communication (IEC) strategies, youth-friendly support services, NGO and government capacity building, and social services to families having children with HIV and AIDS. The project also addresses sexual transmission of HIV/AIDS and adolescent health issues, areas which are not addressed effectively in Romania. The Canadian Public Health Association (CPHA) offers technical assistance which focuses on assessing and making recommendations for strengthening the district level and national HIV/AIDS monitoring and surveillance system, development of a National AIDS Strategy and the establishment of a National AIDS Commission (to include NGOs), HIV/AIDS counseling and support services, NGO institutional capacity building, and IEC strategies and materials. Technical experts also participate in workshops and consultancies in Romania, and organize technical study tours for Romanians to Canada to share experiences with their Canadian peers and to learn new approaches and skills in HIV and AIDS prevention, diagnosis and treatment, counseling and care-giving.

Lessons from HIV projects: The mixture of success and failure in controlling HIV reflects the difficulties of global control. Political commitment, leadership, adequate funding and a coordinated approach with multiple strategies are clearly important.

New developments in technology

In the last several decades, several critical developments have had a profound influence on how infectious disease prevention and control can be addressed. The future will no doubt see many more innovations. At the moment, developing countries, ie those most susceptible to infectious diseases have the least access to modern technologies however the forces of globalization mean this is changing rapidly.

The Internet

In the last ten years, the development of the Internet and electronic communications has had a profound effect on global surveillance and the detection of infectious disease outbreaks. The emergence of instant, globally available electronic communication methods (www, News Services, News groups, e-mail) has the potential to improve responsiveness to outbreaks and other acute events; the quickness with which a response is mounted is often the most important factor in the effectiveness of the response. The onset of cholera in Peru, with rapid spread to 15 countries in the Americas, followed by an economically crippling epidemic of pneumonic plague in India in 1994 led to a WHO-Health Canada partnership to develop the Global Public Health Intelligence Network (GPHIN).

At a meeting of the WHO Executive Board in Geneva, January 1998, concerns were raised regarding the emergence and re-emergence of both national and international infectious diseases (ERIDs) as threats to global public health. An effective early detection and response system was recommended as part of the strategy to mitigate ERIDs; in response to this, and as per the terms of a Memorandum with the WHO, Health Canada established GPHIN.

GPHIN is an Internet-based early-warning application that gathers reports of public health significance from global electronic media (news wires, web sites) and uses human review and computerized text mining to filter, organize and classify this information. Important information is disseminated to public health professionals around the world, by means of a secure web site and e-mailed around the world. Via monitoring of Internet-based information and subsequent notification of public health risks to WHO and other clients, GPHIN serves as a global initiator for appropriate risk management, response and control/prevention measures. GPHIN's scope originally included

infectious disease outbreaks, food/water safety, product safety (e.g. recalls and workplace safety), radiation hazards, and therapeutic products, but has now been expanded to include reports of bioterrorism and environmental hazards.

While there are other public and private health information systems which provide similar or complementary functions (e.g. ProMED), there is apparently no other system being designated to provide a highly scalable, automated approach to information gathering and dissemination for public health professionals. GPHIN receives approximately 18,000 "hits" per month. These are reduced to approximately 200 reports per day that are forwarded to the World Health Organization for verification and further action.

GPHIN has effectively bypassed the traditional national surveillance systems that have been built on the concept of case reports at the local level with aggregation of data from local to regional to national levels. Reporting by nations to the international level (e.g., WHO) was subject to the economic and political concerns existing at the time of the problem. Today, with all their historic limitations, such as lack of uniform case definitions, lack of laboratory capacity to confirm etiology, under-reporting, limited analytical capacity, etc., national surveillance systems are now most useful for trend assessments for well-known endemic infectious diseases and disease control program evaluation. Other systems, such as EnterNet, FluNet, antibiotic resistance monitoring networks, etc. will provide more rapid information exchange and risk assessment than national surveillance systems can manage.

Geographic information systems (GIS)

GIS provides opportunities for better tracking and predicting where diseases occur. It also has the capacity to visually highlight the disease patterns and provide new insights into causal relationships. At the moment it is still relatively early in development however the next 5-10 years are likely to see even better use of remote sensing technology, predictive modeling and more user-friendly GIS-interfaces.

Laboratory-based technology

New laboratory techniques are a major contributor to the control of infectious diseases. New techniques including PCR technology, the use of micro-arrays that permit rapid diagnosis, the role of molecular epidemiology in tracking outbreaks are just some of the techniques that are revolutionizing disease control. As well, the inter-relationship between computers and laboratories has made laboratories a major resource for disease surveillance, especially for notifiable diseases.

Organisational approaches –some examples

The World Health Organization is a collaboration of member states which reflect the majority of countries throughout the world. Its clear mandate is to protect and enhance health throughout the world. It initiates, sponsors and facilitates various disease control activities in partnership with its members, the private sector and the non-government sectors. It has played and continues to play a major role. At the same time, without better resourcing, it is difficult to imagine that it can greatly increase its activities. It does have a major role in, among other activities, monitoring infectious diseases, providing advice, organising and facilitating international approaches to diseases of concern, reporting and responding to outbreaks, managing the International Health Regulations and facilitating groups such as the Global Outbreak and Alert response Network (q.v.)

WHO has promulgated an integrated approach to disease surveillance. This recognizes the fact that the skills and methods of surveillance are similar whatever the disease, and that there is real benefit in ensuring that various people working in surveillance in a country or region can benefit from each others expertise. This has been most helpful and has facilitated capacity-building in many countries however there is still much more work needed. For instance, the relative lack of surveillance available from high risk countries in Asia highlights the dearth of data, and the lack of capacity for obtaining such data.

A major accomplishment of the WHO has been establishment of the Outbreak Verification List (OVL). This involves finding out that a suspected outbreak has occurred, verifying the outbreak, confirming the cause, and notifying, on a confidential basis, relevant people throughout the world. This list provides an important means of communication about outbreaks and has been extraordinarily valuable since its inception (Grein et al, 2000). It is, however insufficient for the global control of infectious diseases. It does not always include all the diseases of international relevance, there is no automatic response in terms of controlling the outbreak or preventing new ones. The list appears to be erratic in what is published, not a fault of the list but a fault of the notification process by member countries. There are neither sanctions nor clearcut benefits in being listed. This is clearly a matter for the member states to resolve.

WHO has participated in a number of disease outbreaks and many disease control initiatives. It sends teams to areas of need, on request from member countries, sometimes in collaboration with other organizations such as GOARN (qv).

The Centers for Disease Control and Prevention primarily exists to protect the interests of the United States of America, although its findings, modus operandi, training procedures and guidelines are widely promulgated and used. As well, CDC provides significant international assistance both in terms of routine control of infectious diseases and also in outbreak investigation.

The European Commission provides another example of international collaborations in which surveillance, and outbreak investigation have been made Commission-wide priorities, with resultant funding of EpiET, an applied training course in infectious diseases.

Many non-government organizations such as the International Red Cross, Medecin Sans Frontieres and many others provide treatment, care, run programs and generally contribute to infectious diseases control in whichever areas of the world are in need.

Global Outbreak Alert and Response Network (GOARN)

WHO has recognized the value of new systems for international exchange of information and has launched GOARN, a consortium of participating nations to build an international alert and rapid response capability. With rapid information from all over the globe on outbreaks of infectious disease from multiple sources, WHO is now in a position to collaborate with affected countries to mount disease control efforts. When news of an outbreak reaches WHO, immediate contact is made with the affected nation's health authorities to verify the existence of a problem. If confirmed, WHO offers to send a team of government and non-government personnel drawn from GOARN countries (e.g., clinicians, epidemiologists, laboratory personnel, health educators, etc.) immediately to the affected country to aid in the control efforts. The recent, largest ever epidemic of Ebola Hemorrhagic Fever in Uganda is a good example of a successful implementation of GOARN with more than thirty governmental and non-governmental organizations participating under the auspices of WHO.

What do we need for control of infectious diseases?

A plethora of multi-lateral and bilateral international efforts and initiatives are underway to respond to the growing acknowledgement of the threat posed by infectious diseases. However, many of these efforts remain disease specific. WHO's Expanded Program on Immunization has made major progress against vaccine preventable diseases. The global effort to eradicate polio illustrates WHO's capacity to

mobilize countries and the non-governmental sector (e.g. , Rotary International) in a coordinated well financed program. Recently the Program added yellow fever vaccination campaigns in endemic and at-risk areas to its program objectives. Yet many programs such as WHO's STOP TB and Roll Back Malaria remain as single focus, complex, multi-laterally, and bilaterally financed efforts.

The history of the global response to HIV illustrates some of the increasing international complexity for responding to an infectious agent. WHO's Global Program on AIDS (GPA) became the initial focal point for mounting a response to prevent transmission of the virus and ameliorate the impact of infection and illness. Initial attempts to channel international funding led to many early HIV prevention and control plans in countries that were affected early in the pandemic. However, dissatisfaction with WHO's pace for supporting member countries by a large number of non-governmental organizations coupled with concerns by other United Nations organizations and donor countries eventually led to many bilaterally funded programs and finally the formation of UNAIDS, a consortium of UN agencies charged with coordinating the anti-HIV efforts. Although many projects demonstrated the feasibility of many prevention interventions, failure to truly control the spread of the virus has led to new political initiatives. The very recent creation of the UNGASS[3] Fund by the United Nations has already generated considerable discussion and debate between the European Community, the US, Japan, non-governmental organizations and others over the processes and procedures for the international management of this fund.

If we are to control infectious diseases throughout the world, we need several elements:

Surveillance We need to know what diseases are occurring and the occurrence and trends of the risk factors associated with diseases. All countries need to know this for their own health planning. Countries have to know what is happening if they are to help themselves. They need to know about their own diseases, their own outbreaks. There is plenty of history of people trying to find out about diseases in another jurisdiction but did not bother to let local people know what was happening. This is useless. Imagine if someone came into your house and left again, then suddenly you read in the newspaper something about you, your family or your house. None of us would like this. It is no different with a country. Help people, if they want help, to help themselves. Besides, there is no gain in letting someone else know about your diseases before you know – so from the perspective of other countries, either local surveillance that benefits those people or no surveillance! Then we

[3] United Nations General Assembly Special Session on AIDS, New York June 2001. The United Nations Director-General has estimated that a sum of approximately us$10-12 billion will be required to fund effective HIV prevention and control programs worldwide. The fund is currently capitalized at approximately us$1.2 billion.

can have effective regional and global surveillance. Regional and global surveillance will always depend on information obtained more locally, however structures based on regional (and global) surveillance can facilitate and work in partnership with local areas, so that both benefit.

There needs to be **outbreak investigation capacity**, so local investigations can be done, and so local people see the benefit of conducting outbreak investigations. Again, regional and global structures can help, so that both they and the local jurisdiction can benefit.

Technical capacity in a range of areas is essential. This includes a whole range of technical expertise such as clinical and laboratory scientists, social scientists, political scientists, epidemiologists etc.

Applied research that is useful and relevant for a particular country needs to be undertaken to determine which policies should be adopted and the best methods of implementation. Central to better control of infectious diseases is a clear nexus between research, policy, and practice. A major challenge for ensuring the delivery of more cost-effective services is to sharpen our focus on research priorities for solving practical problems. A good example of this is the relationship between antibiotic prescribing and the rise of drug resistant organisms. From the scientific perspective it is clear that unregulated use of antibiotics leads to more drug resistance. Policies in this regard however are patchy and the transfer of policy to practice is even sketchier. We need research that seeks the opinions of prescribers and specifically identifies the barriers to implementing policy surrounding appropriate prescribing of antibiotics. We also need research that examines the barriers to nation states implementing e.g. appropriate regulatory systems to ensure appropriate antibiotic use.

Policies need to be **locally-relevant**. This means they need to take into account local practices and cultures, and be financially and politically appropriate. This can not be done by an export-import approach. Although international organizations such as the WHO and the World Bank have played an important role in developing and strengthening both international and national surveillance systems there is need for more focused local policies. International organizations have the knowledge, skills and funding to support local approaches.

Each country or region needs skills to undertake **monitoring and evaluation** of its programs, and to ensure the programs are serving the target populations.

Barriers to control of infectious diseases

A major constraint for developing integrated systems for controlling infectious disease is that the day-to-day responsibility for control lies with nation states. Neither organisms nor their vectors (including humans) however, recognise national borders. As the responsibility lies with nation states, whether the problem is an outbreak, establishment of surveillance or development of a national approach to control, the primary responsibility of those involved inevitably lies with their employer, viz. their nation state government. This means that it is essential that any cross-jurisdictional approaches must ensure that they have agreement from the various relevant stakeholders but also that the 'rewards' for participating in such an approach are obvious. There must be a clear benefit in provision of knowledge (eg trade offs from knowing about other countries, and potential for prevention, helping sorting out outbreaks, acknowledgement of potential for 'sharing the blame' etc.) Attempts to coordinate an international approach include the establishment of the Global Outbreak and Alert Response Network (GOARN). This has certainly led to better coordination of outbreaks in a few instances however the organization is still embryonic.

Recognition of the importance of economics and poverty is essential - infectious diseases are closely related to poverty, with cycles of poor education, poor job prospects, inadequate money, inadequate nutrition, and poor and crowded housing all facilitating the transmission and expression of infectious diseases. International interventions to decrease poverty can have a major effect on infectious diseases, but are beyond the scope of this paper.

The role of climate change is still unclear. What does seem clear is that some parts of the world will have an increase is particular diseases, particularly vector-borne diseases, and that this will have an impact on attempts at disease control, especially when such attempts involve cross-border issues.

What lessons can we learn?

Examining a range of programs that reflect various degrees of success it appears that there are a range of factors contributing to success.

Leadership

As in most business or social groups, change requires good leadership. This is to enable the inspiration of other people, to motivate, to facilitate the provision of funds and human resources. Without leadership, infectious diseases control is not possible.

Ensuring the relevant people and groups are involved

Making sure the relevant people and groups are involved is key to any project, yet one that is sometimes overlooked. This is particularly so when working with unfamiliar cultures, and especially when social and cultural practices may enhance spread of disease.

Preparedness to be flexible in program delivery, and adaptable to local circumstances

Any program or approach to infectious diseases control requires recognition of local or changing circumstances. It is essential that any new initiative have sufficient flexibility to ensure adoption of new approaches.

Partnership and multisectoral approaches

One clear lesson from successful projects is the importance of partnership, particularly the success of partnerships where there are multiple partners. It is unclear whether multi-partner partnerships appear more successful because they tend to be larger (and hence need more partners), whether the time taken to develop such partnerships is long and therefore there is more 'ownership' by all partners or whether perhaps the very fact that many people and groups are involved make it more difficult for a project to fail if eg one partner drops out. Is there, for instance, a kind of peer group pressure that operates in multi-partner partnerships? In some ways, the reasons are probably less important than the fact that they work.

There is evidence that multi-sectoral programs that address socioeconomic factors as well as health care needs can bring about tremendous improvement in the health of people.

Funding

Funding that is sufficient for the task and available for sufficient time for initiatives to be established and sustained is clearly important. This links back to the importance of multiple partners – the presence of multiple partners ensures that the project is not entirely dependent on the funding capacity and agreement of a single partner, which probably makes the particular activity more sustainable over time.

Articulated plans, objectives and strategies.

Another apparently relevant factor in success is the importance of articulated plans, objectives and strategies. Multiple partners all with the same clear objectives and plans appears important, as does the use of multiple strategies working towards one aim.

So what do we do?

So what would we want in an ideal world, acknowledging that we can never eliminate infectious diseases from the world, but that we have to manage and live in sometimes uneasy equilibrium with the microbiological world. (Table 6)

Table 6: What do we need to control infectious diseases around the world?

- We would want to know what was happening about infectious diseases, their causal agents and the risks that lead to individual infections.
- We would want to have excellent knowledge about the disease.
- We would want to know when outbreaks occurred
- We would want to be able to respond whenever a response was needed
- We would want to be able to prevent diseases occurring
- We would want to be able to initiate and maintain programs, and to be able to monitor and evaluate such programs.
- We would want to be sure we had enough scientific skills to apply to the problem
- We would want to undertake applied research to better prevent disease and to better implement the knowledge already in existence.

Since the geographic border no longer offers any degree of protection, the management of mobile populations and goods that pose a threat of international spread of communicable diseases must rely on the following:

- Intensified surveillance and early warning of outbreaks of emerging and re-emerging communicable diseases
- International support for WHO's GOARN
- Intensified international collaboration for controlling and eliminating (where possible) major endemic communicable diseases
- Research and development of new paradigms to address infectious diseases in mobile populations

This means that individual countries, regions and the world need

- Education and training
- Surveillance
- Outbreak investigation capacity
- Scientific, policy analysis and administrative capacity
- Appropriate use of technology
- Networks.

These, however will be insufficient unless we use our skills and learn lessons from the successes and failures of the past. In particular, we need to ensure these elements work well across national borders.

Increasing global threats from both re-emerging and emerging infectious diseases places new demands on the world to address global and regional issues for better control of infectious diseases. Current international linkages between government agencies, and with the research and private sector are inadequate to meet these new demands, but we can improve them, if we have the will to do so.

The world community, our global village, can help with all these aspects in ways that are respectful of others, that ensures high quality capacity building in all these areas. Buildings can't solve these problems, but humans can. We can, if we work together, and learn lessons from both our successes and failures.

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