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Tuberculosis Control in the Americas

Introduction

Tuberculosis, a preventable and curable disease, remains a major threat to public health in the Region of the Americas. Although effective drugs and treatments as well as measures and procedures for its control have been known for several decades, we are presently witnessing a recrudescence of the disease throughout the world.

Several factors in the Region of the Americas, moreover, have been creating conditions that have led to an exacerbation of the tuberculosis problem. In these countries, the **human immunodeficiency virus (HIV)** pandemic, the rise in poverty, which has accentuated the already inequitable access to health services, the growth of marginal populations, and the migration in search of a better quality of life have all made their contribution. This situation, compounded by weaker, less efficient tuberculosis control programs, has led to a serious problem in some countries that may jeopardize the possibility of controlling the disease in the future: **resistance to anti-tuberculosis drugs**. Accordingly, the Regional Program on Tuberculosis has provided collaboration and advice to the countries through activities to reevaluate the strategies pursued to date, with the object of implementing the strategy of directly-observed treatment, short course (DOTS).

The Tuberculosis Situation in the Region

Between 1986 and 1996 the number of new cases of tuberculosis reported to PAHO/WHO has generally ranged from 230,000 to 250,000 cases per year, with an annual incidence rate of 30 to 35 per 100,000 population. According to the reports for 1996, a total of 242,157 cases of all forms of the disease were identified in 27 countries in the Region, with an incidence rate of 31.0, while new cases of bacilliferous tuberculosis numbered 134,003, with a rate of 17.1 per 100,000 population. (Table 1).

It is estimated that case notification in the Region has been able to detect 65% of all sources of infection, representing an annual incidence of roughly 400,000 cases. This rate of detection is considered a positive finding, since it is close to the goal of 70% detection proposed by WHO by the year 2000. The trend for all forms of tuberculosis and new bacilliferous cases, in terms of case numbers and rates, held stable during the period 1990-1996.

One third of new cases of tuberculosis, which are unreported and untreated, maintain the transmission of the infection and are responsible for considerable illness and death.

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Table 1. Reported incidence of all forms of tuberculosis and new bacilliferous cases, Region of the Americas, 1990-1996

Year	Tuberculosis – all forms Cases	Tuberculosis – all forms Rate x 100,000	Tuberculosis ABF[b] (+) new Cases	Tuberculosis ABF[b] (+) new Rate x 100,000
1990	231,182	32.1	123,666	17.2
1991	252,247	34.5	124,453	17.0
1992	253,239	34.2	136,035	18.3
1993[a]	166,640	22.2	104,931	13.9
1994	242,018	31.7	142,405	18.7
1995	238,372	30.8	135,105	17.5
1996	242,157	31.0	134,003	17.1

Sources: Global TB Control, WHO Report 1998. Geneva: WHO and United Nations Population Division, World Population Prospects: 1996 Revision,. New York: United Nations.
[a]In 1993 cases in Brazil were not reported.
[b] Acid-fast bacillum

Based on the reports received from the countries of the Region in 1996, the severity of the tuberculosis situation varies among the countries of Latin America. This makes it possible to rank them, establishing priorities for the application of control measures based on their national situation and its repercussions for the Region.

- Two countries have rates of over 85 per 100,000 population (Bolivia and Peru),
- Fourteen countries have rates of 25 to 85 per 100,000 (Argentina, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Panama, and Venezuela),
- Seven countries have rates below 25 per 100,000 (Belize, Costa Rica, Canada, Cuba, Mexico, Uruguay, and the United States of America).

PAHO estimates of the rates for new cases in the countries (Table 2) are higher than the figures reported for 1996. The countries generally fall into groups that are rather similar to those indicated above in terms of the reported incidence rates, with the exception of the over 85 per 100,000 group, which increased markedly. Concerning the distribution of infectious tuberculosis cases by age and sex, the disease affects all ages, reflecting considerable transmission of the tubercle bacillus among the population, with the added complication of frequent reinfection. It must be stressed that in the majority of the countries of the Hemisphere, a high proportion of the cases occur in the 15-54 year age group; this is the most economically active population, in which HIV infection is increasing the spread of the disease. (Table 3).

Table 2. Estimated tuberculosis incidence rate in Latin America, 1995

>85/100,000	25-85/100,000	<25/100,000
Bolivia	Argentina	Costa Rica
Dominican Republic	Brazil	Cuba
Ecuador	Chile	Puerto Rico
El Salvador	Colombia	Uruguay
Guatemala	Mexico	
Haiti	Nicaragua	
Honduras	Panama	
Peru	Paraguay	
	Venezuela	

Table 3. New cases of tuberculosis AFB (+) (rates per 100,000 population) by age and sex, Region of the Americas, 1996

Age groups (years)	Men	Women	Total
0-14	1.63	1.84	1.74
15-24	14.66	11.61	13.15
25-34	15.64	11.89	13.77
35-44	14.34	9.49	11.91
45-54	15.76	9.46	12.57
55-64	18.41	11.70	15.04
65 and over	16.00	8.13	11.44
Total	11.57	8.16	9.86

Source: Global TB Control, WHO Report 1998. Geneva:WHO

Even though tuberculosis mortality registers point to problems of underreporting similar to those cited with respect to incidence, not to mention problems related to certification of the cause of death, a distinctly downward trend is visible in most of the countries, according to the data available for the period 1960-1990.

In 1960, 53,486 deaths from tuberculosis were reported in the Region, declining to 41,579 in 1970, 31,184 in 1980, and 23,154 in 1990. The decline registered over the 30-year period is 56.7%; this figure may be even higher, since in 1960 and 1970 Brazil did not report the total deaths from this cause. Except for the Dominican Republic and Nicaragua, where the number of deaths from tuberculosis rose in the period analyzed, the rest of the countries show a downward trend, with a high percentage of reduction in countries with programs of recognized efficiency, such as Cuba, the United States of America, Canada, Uruguay, and Chile.

PAHO estimates put the number of deaths from tuberculosis at some 60,000 per year, assuming that many of the patients at high risk of dying from the disease are neither reported nor treated. Accordingly, it is recommended that the countries evaluate the case-fatality from tuberculosis registered cases in each treatment cohort, taking into account the patient category (new bacilliferous case, relapse, treatment dropout, recovered, etc.), the various treatment protocols employed, and whether or not the drugs were administered under supervision.

Thus, according to the data from the cohort studies conducted by the countries of the Region, case-fatality ranging from 3.2% in Peru, 4.4% in Nicaragua, and 7.7% in Chile up to 17.2% in Puerto Rico can be observed. A study of case-fatality among treated patients should determine the role played by late diagnosis and treatment, the ineffectiveness of the treatment protocols employed, the absence of supervision in administering drugs, and other factors linked to the health services and the patients themselves, such as greater case-fatality among patients who are HIV-positive.

Factors Fostering the Re-emergence of Tuberculosis

HIV/AIDS

As of December 1997 the epidemiological surveillance system of the Acquired Immunodeficiency Syndrome/ Program on Sexually Transmitted Diseases (AIDS/STD) reported a total of 812,162 cases and 472,562 deaths in the Region. The countries with the highest cumulative rates per 1 million population are: Belize (171.9), Honduras (163.2), the United States of America (138.1), Brazil (100.2), Panama (90.8), Guatemala (76), El Salvador (70.7), and Argentina (61.9).

According to estimates made in 1994 by a group of PAHO/WHO experts, approximately 1,400,000 people are infected with HIV, and more than 330,000 cases are infected with both *M. tuberculosis* and HIV in Latin America and the Caribbean alone. From projections based on studies on the prevalence of dual HIV/TB infection conducted in the Region, it is estimated that some 3% to 5% of the new tuberculosis cases currently diagnosed in the countries are attributable to simultaneous infection with HIV. In Haiti, the Dominican Republic, and Honduras the prevalence of dual HIV/TB infection is high, posing both a threat from the future behavior of the disease and a challenge for its control.

At the regional meeting of Heads of National Tuberculosis Control Programs held in 1997 some countries presented isolated studies on the prevalence of dual HIV/TB infection covering different periods of time and involving different numbers of patients, as summarized in Table 4.

The principal weaknesses observed in the national programs have consisted of:

- the lack of priority given to TB control activities, the result of limited government support
- the lack of drugs
- disorganization of the laboratory network
- insufficient supervision and training

Table 4. Prevalence of HIV infection in tuberculosis patients in selected countries of the Region of the Americas

Countries	Period	TB Cases	HIV(+)	%
Argentina	1995	13,450	290	2.2
El Salvador	1996	1,513	43	2.8
Guatemala	1996	1,155	63	5.4
Honduras	1986-1997	50,650	1,562	3.1
Mexico	1990-1994	1,187	37	3.1
Nicaragua	1989-1997	2,086	1	0.05
Uruguay	1997	746	45	6.1

Control Programs in the Region

Throughout the Region the ministries of health provide most of the resources for program operations, including drugs and supplies. The budgets allocated to tuberculosis control have nevertheless been considerably reduced in the past two decades. In fact, in recent years, several countries with a high incidence of the disease have managed to obtain external financing from bilateral agencies and nongovernmental organizations (NGOs). A small number of countries have increased funding from their national treasury for the purchase of drugs and supplies for the program.

- absence of a manual on up-to-date standards,
- deficiencies in or inadequate registry and reporting systems, and
- deficiencies in the evaluation of the results of control measures.

A different situation has arisen in the countries with the most efficient programs in the Region, where there has been a clear government commitment, guaranteeing control of the disease, periodically evaluating the program, and conducting operational studies to respond to the main problems faced by the program.

Health sector reform is under way in nearly all the countries in the Region, directly influencing the progress of disease control programs, including those to combat tuberculosis. As part of the reform, the decentralization of activities at the state, regional, and local levels of the health sector includes, in the specific case of tuberculosis control:

- reorganization of the program with new roles for the various levels;
- decentralized planning and procurement of drugs and supplies;
- separation of the registry, information, and evaluation systems;
- joint training with other programs; joint supervision with other programs; and
- reorganization of health services networks and laboratories.

Decentralization can represent an opportunity for improving the identification of local problems and needs and bolstering local commitment to address the problems identified by the control programs, with a view to improving the efficiency and effectiveness of interventions such as the DOTS strategy.

Results of the Application of the DOTS Strategy in the Region

The DOTS strategy is one of the most cost-effective health interventions. This general strategy consists of five basic elements: commitment by the government to implementing a program to combat tuberculosis; passive case detection through diagnosis by smear microscopy; directly-observed treatment, short course, of all cases with positive smear microscopy; regular drug supply; and a system for monitoring and evaluating the program.

In order to respond to the worldwide tuberculosis problem, WHO has proposed that the countries adopt two goals for controlling the disease by the year 2000 through reduction of morbidity, mortality, and transmission of the disease: curing 85% of all cases confirmed by positive sputum smears and detecting 70% of new cases.

The results of applying the DOTS strategy in the Region can be evaluated by comparing the results of the countries that apply the strategy and those that do not, through two indicators that measure the efficiency of control measures: the detection/cure rates of patients with bacilliferous TB and the degree of resistance they display to anti-tuberculosis drugs.

a. Patient Detection and Cure

Effective tuberculosis control depends on uninterrupted surveillance of the disease and its dynamics through case reporting and monitoring and evaluation of the programs. The most important indicator is **to analyze the results of the treatment administered to the cohorts of registered bacilliferous patients**.

In 1995 a substantial number of countries and territories in the Region reported on their cohort analysis of the treatment outcomes for patients with positive sputum smears: Eleven countries and one territory in the Region (Belize, Bolivia, Chile, Cuba, Guatemala, Nicaragua, Peru, Puerto Rico, the United States of America, US Virgin Islands, Uruguay, and Venezuela) that apply the DOTS strategy reported satisfactory outcomes for a total of 53,149 cases with positive sputum smears. At the end of the short-course treatment, 67.7% of the patients reported met the criterion for cure, that is, a negative sputum smear. If those who completed the treatment without final bacteriological examination are taken into account, 76.3% demonstrated a complete cure/treatment (success rate). The success rate of the latter group increased to 84% when only evaluated cases were used as the denominator.

The situation was different in the 13 countries and territories (Argentina, Brazil, Dominican Republic, Ecuador, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Suriname, and Trinidad and Tobago) that reported cases but, either did not apply the DOTS strategy completely, or did not apply it at all. These countries registered a total of 72,705 cases; however, the patient cure rate was only 11.8%, increasing to 29.8% when the cases that completed treatment without bacteriological confirmation are considered. It is interesting to note the differences between the countries that apply the DOTS strategy, in which there was no evaluation of treatment outcomes in only 9.1% of the reported cases, and those that do not apply DOTS, in which 59.2% of the patients were not evaluated and their treatment outcomes are consequently unknown.

The importance of applying the DOTS strategy is illustrated by the fact that the countries of the Region that have been applying it for over 20 years, for example, Cuba, Chile, and Uruguay, have attained cure and detection rates approaching or even exceeding the goals proposed by WHO for the year 2000. More recently, Peru, the United States of America, and Nicaragua have applied the DOTS strategy and have achieved significant success in detecting and curing their patients. Since 1993, political and financial commitment in the United States of America, as well as innovative activities and the application of directly-observed treatment have led to a new decline in incidence rates for active tuberculosis. Peru has had a similar experience, resulting in a dramatic shift in the trend of tuberculosis incidence beginning in 1991. In that year, prior to the application of the DOTS strategy, estimates put the cure rate at only 50% of reported cases (no information is available on the patients treated); by 1996, success rates of 91% of the patients treated had been achieved (89% among the reported cases), while the dropout rate plummeted from 47% to 4%.

In 1997, 14 countries in the Region reported that they were conducting cohort analysis of the treatment outcomes of patients with positive sputum smears, although deficiencies can still be observed with respect to the number of patients included among those reported, the lack of a breakdown by patient categories, and inadequate bacteriological follow-up of patients treated. Another group of countries—Colombia, Costa Rica, Dominican Republic, Haiti, Panama, and Paraquay—had not yet systematically implemented the cohort study with national coverage.

b. Monitoring of Drug Resistance

Resistance to anti-tuberculosis drugs and, specifically, multidrug resistance (MDR) to Isoniazid and Rifampicin, has been considered an emerging phenomenon that poses a growing threat to tuberculosis control in the countries in the Region. As part of a global working group coordinated by WHO and the International Union Against Tuberculosis and Lung Disease (IUATLD) to monitor drug resistance in the treatment of tuberculosis, 11 countries (Argentina, Bolivia, Brazil, Canada, Chile, Cuba, Dominican Republic, Mexico, Nicaragua, Peru, and the United States of America) have recently concluded or are in the process of conducting national surveys on drug resistance and tuberculosis; Colombia, Ecuador, Honduras, Paraguay, and Venezuela are projected for inclusion in the 1998-1999 plan. These studies have provided an overview of the resistance problem, especially multiresistance to anti-tuberculosis drugs in the Region.

The results of the studies on primary resistance to anti-tuberculosis drugs conducted in the countries in the Region, while not yet alarming, nevertheless point to a phenomenon fully confirmed worldwide: when programs efficiently implement control measures and the countries apply the DOTS strategy for a certain number of years, the prevalence rates for drug resistance, and specifically multidrug resistance, are very low and do not pose a problem for tuberculosis control. Countries that do not apply the DOTS strategy and achieve only low levels of efficiency in their control programs face a totally different scenario. The most serious situation has emerged in the Dominican Republic (1994-1995), where irregular supply and the improper use of drugs under an inefficient program has led to high rates of resistance, with multidrug resistance figures of 6.6% in new patients with positive sputum smears. In the case of Argentina it should be pointed out that the MDR figure of 4.6% was due to the inclusion in the sample of a group of AIDS patients infected with multidrug-resistant tuberculosis, the consequence of outbreaks of infection in hospitals where both types of patients were admitted.

In summary, according to the data from the studies on resistance to the anti-tuberculosis drugs provided by the Global Program of WHO in 1997, countries that do not apply the DOTS strategy and whose control programs are inefficient have the highest rates of MDR/TB. This poses a threat to tuberculosis control in these countries from resistant strains of bacilli, making treatment with the current arsenal of drugs ineffective for patients with this type of infection. (Table 5).

Table 5. Primary resistance to anti-tuberculosis drugs (%) in Latin America national surveys concluded between 1994 and 1997

COUNTRY	ISONIAZID	RIFAMPICIN	SM[c]	ETM[d]	PR[e]	MDR[f]
Argentina[a]	7.8	5.1	7.6	3.1	12.5	4.6
Bolivia[a]	10.2	6.0	9.8	5.0	23.9	1.2
Brazil[a]	5.9	1.1	3.6	0.1	8.6	0.9
Cuba[b]	2.0	0.9	6.9	0.0	8.3	0.7
Peru[a]	7.5	4.6	8.7	1.6	15.4	2.5
Dom. Rep.	19.8	16.2	21.1	3.6	40.6	6.6
Chile[b]	1.8	0.1	4.9	-	9.6	0.5
Uruguay[b]	1.02	0.1	2.5	0.0	2.4	0.8

[a] Anti-Tuberculosis Drug Resistance in the World. (WHO/ IUATLD Global Project on the Monitoring of Resistance to Tuberculosis Drugs). WHO/TB/97,229, 1997 Geneva.
[b]National TB control programs
[c]Streptomycin
[d]Ethambutol
[e]Primary resistance to one or more drugs (does not include Rifampicin in combination with Isoniazid)
[f]Resistance to Isoniazid and Rifampicin

Regional Plan of Action for the Implementation of DOTS

In 1995 there were 11 countries and 1 territory in the Region that applied the DOTS strategy and 13 countries that did not apply it completely or that had not yet initiated its application. This situation has changed in the past two years, and Argentina, Ecuador, El Salvador, and Mexico have made remarkable progress, creating clearly successful demonstration areas for DOTS implementation. Mexico launched the strategy in 1996 with demonstration areas in some states, extending them to the rest of the country in 1997; this meant an increase in its patient rates due to improved reporting and case-finding.

Brazil, Colombia, the Dominican Republic, Honduras, and Paraguay have agreed to apply the strategy and have initiated activities to create demonstration areas in selected parts of the country. Panama and Costa Rica are reorganizing their programs this year, and the English-speaking Caribbean countries are striving to improve their network of diagnostic laboratories and prepare uniform control standards.

PAHO's Regional Program is projecting that by the year 2000 all the countries will be applying the DOTS strategy. Taking into account the current tuberculosis situation and that of the control programs in terms of their efficiency and level of application of the DOTS strategy, the chart next page shows the distribution of the countries according to their prospects for meeting the targets for patient detection and cure by the year 2000.

Group A Goals met in 1998	GROUP B Goals to be met by the year 2000	GROUP C Goals to be met between 2001 and 2005
1. Chile	1. Argentina	1. Bolivia
2. Cuba	2. Belize	2. Brazil
3. Nicaragua	3. Costa Rica	3. Colombia
4. Uruguay	4. El Salvador	4. Dominican Rep.
5. Peru	5. Honduras	5. Ecuador
	6. Jamaica	6. Guatemala
	7. Mexico	7. Guyana
	8. Panama	8. Haiti
	9. Paraguay	9. Suriname
	10. St. Kitts and Nevis	
	11. St. Lucia	
	12. Trinidad and Tobago	
	13. U.S.A.	
	14. Venezuela	
	15. Other English-speaking Caribbean countries-territories (not mentioned above)	

References: 1. WHO. National Tuberculosis Programme Review. Experience in 12 countries during the period 1990-1995. WHO/TB/96.217. Geneva, 1996. 2. World Bank. World Development Report 1993: Investing in Health. New York. Oxford University Press, 1993.

Source: HCP/HCT Division of Disease Prevention and Control, Program on Communicable Diseases, PAHO/WHO.

V Argentinean Conference of Epidemiology and Health Care

First Epidemiology Conference of the Mercosur Region

II Meeting of Argentinean Members of the International Epidemiological Association

Buenos Aires, Argentina - 2 to 4 September 1998

The central subject of the event will be: *Epidemiology in the evaluation of rational use of health technology*. During this event, the "Prof. Dr. Enrique Nájera" award will be presented.

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El Niño and its impact on health

In recent years there has been growing interest in links between El Niño (and other extreme weather events) and human health. Many studies have shown that pronounced changes in the incidence of diseases could occur in parallel with the extreme weather conditions associated with the El Niño cycle.

Not very often predictions about El Niño and other climate changes are utilized in the planning and administration of health programs. In fact, existing meteorological data are seldom used to analyze seasonal differences in the incidence of disease.

“El Niño”, Spanish for the Christ child, is used to describe an anomaly in the flow of ocean waters along the west coast of South America which can occur around Christmas time--hence El Niño. This anomaly is the result of the nutrient-rich cold water of the coastal Humboldt Current being replaced by eastward-flowing warm ocean water (which is nutrient poor) from the equatorial Pacific. El Niño events have occurred every 3 to 5 years, on average, since meteorological records began in 1877; they are associated with catastrophic declines in fisheries along the Pacific coast of South America.

The Southern Oscillation (SO) is a large-scale atmospheric “up and down” centered over the equatorial Pacific Ocean. The variation in pressure is accompanied in surrounding areas by fluctuations in wind strengths, ocean currents, sea surface temperatures, and precipitation. The SO and the warm waters of the El Niño are part of the same climate phenomenon referred to as ENSO (El Niño/ Southern Oscillation). ENSO influences climate in distant regions: droughts in South-East Asia, parts of Australia, and parts of Africa, and heavy rainfall and flooding in arid areas of Africa and South America have been observed during El Niño years, while the Indian summer monsoon sometimes weakens and winters in western Canada and parts of the northern United States of America become milder. Overall, disasters triggered by drought are twice as frequent worldwide during El Niño years.

Forecasting techniques to predict and measure El Niño events have been greatly improved in recent years. One such technique, the multivariate ENSO index, indicated that there were 3 such extreme events during 1950-1980. However, since 1984, according to the same index, there have been 4 major El Niños. The longest single El Niño period on record occurred from 1990-1995. The association of this apparent increase in frequency to global warming has not yet been established.

El Niño and similar weather disturbances affect human health mainly through natural disasters and related outbreaks of infectious diseases. However, it requires advanced analytical methods to be able to estimate how many human deaths and illnesses are linked to El Niño since the health effects result from an interaction of abnormal weather events with factors such as population over-crowding, health status, sanitation infrastructure, vector and reservoirs ecology.

On the pacific coast of South America, climate forecasts related to upcoming rainy seasons are based on the wind and water temperatures in the tropical Pacific region and the output of numerical prediction models. Four forecast possibilities exist: (1) near normal conditions; (2) a weak El Niño with slightly wetter than normal growing seasons; (3) a full-blown El Niño with flooding; or (4) cooler than normal waters offshore, with higher than normal chance of drought.

El Niño can cause dramatically increased or decreased rainfall, which can lead directly to natural disasters such as floods or droughts. In addition, high wind events such as tornadoes may increase in frequency or intensity. These effects can occur at great distances from the ENSO phenomenon and tend to be more dramatic in particular areas. These disasters may cause direct injuries and deaths as well as destroy crops and property, lead to famine and interrupt development. They make already-vulnerable populations more vulnerable. Research has shown that the number of people affected by natural disasters worldwide is greater during and immediately following El Niño year than in the year preceding El Niño event.

In the Americas there are several changes in precipitation patterns associated with ENSO events. In North America there is generally greater than normal precipitation in the Gulf and northern regions of Mexico from October to March. In the Great Basin of the United States, there is greater than normal precipitation from April to October.

In Central America and the Caribbean, precipitation is lower than normal and the dry season occurs from July to October during an El Niño event. It is suggested that a region of ENSO related precipitation extends from southern Mexico and Guatemala southward into Panama and eastward into the Caribbean. South America generally experiences extremes of dryness or wetness, depending on the sub-region.

In the northeast sub-region of South America (north equatorial Brazil, French Guiana, Guyana, Suriname, and Venezuela) there is less precipitation from July to March. In southeastern South America (southern Brazil, Uruguay, and parts of northeastern Argentina) there is greater than normal precipitation from November to February.

The Pacific coast of South America in Ecuador and Peru also experiences more rainfall than normal during El Niño years.

In the Amazon sub-region low rainfall does not coincide with ENSO events but lags one year behind. However, due to the lack of historical precipitation data from this sub-region and the sub-region's complex rainfall patterns, it is hard to construct a regional index for the entire basin. In other words, less than normal rainfall would more than likely occur, but precipitation extremes are not as highly correlated with ENSO as they are in other parts of South America. The Andean sub-region is also affected by ENSO. There is, however, insufficient information available to make generalizations.

Physical Infrastructure of the Health Services

Damage produced by flooding has affected equipment, supplies and health services facilities. In Peru, it was reported that 9.5% (437/4,576) of health facilities were damaged by floods, with hospitals showing a damage rate of 2% (9/443) and other health centers 10.3% (428/4,133). Approximately US$ 1,500,000 was allocated for waterproofing roofs, installing drains, digging ditches, protecting equipment, installing generators, and building alternative water supply systems.

In Ecuador, mainly flooding damaged seven out of 299 (2,3%) hospitals. The already defective sewerage systems were affected, and drinking water supply was interrupted.

In the region of the Americas the damage to the physical infrastructure of health facilities from El Niño is predictable and are due to shortcomings and errors in the planning, design, and construction of these facilities, and to the non-existence of disaster mitigation programs. Contributing factors are the characteristics of the sites selected, i.e., the location of the land, its geology and climate, building systems and materials, water supply and electricity services, and geographical accessibility.

The 1997 El Niño event that is expected to last until mid-1998 has already been associated with drought-related forest fires. These fires have mainly been caused by human activity but the lack of seasonal rains has led to their spread over wide areas and the fires are now affecting virgin rain forest. Fires occurring in the Amazon rain forest pose a major ecological threat to both farming and traditional indigenous communities. During periods of drought, the risk of forest fires increases, leading to a loss of green areas, property, livestock, and human lives, and to atmospheric pollution increases due to the suspension of particulate matter in the air. In the Roraima region in northern Brazil there have been more than 200 fires, although no casualties have been reported to date, the fires have destroyed 37,000 Km^2 of forest and endangered the lives of over 45,000 area residents.

In Bolivia, estimates put the number of persons affected by the drought at more than 300,000. The most significant impact of the drought has been a shortage of drinking water followed by a decrease in the water available for irrigation and livestock.

El Niño has also been associated with very destructive flooding in South America. Ecuador and Peru have been particularly affected. In Peru's Piura region, the heavy rains have not only raised the water level of the Piura River, but they have also oversaturated the soil, causing area dwellers (complete with their livestock and meager belongings) to move to temporary shelters on the outskirts of Piura. Some 300 families have been displaced to date and if the situation persists this number is expected to rise to 1,200.

Communicable Disease Transmission

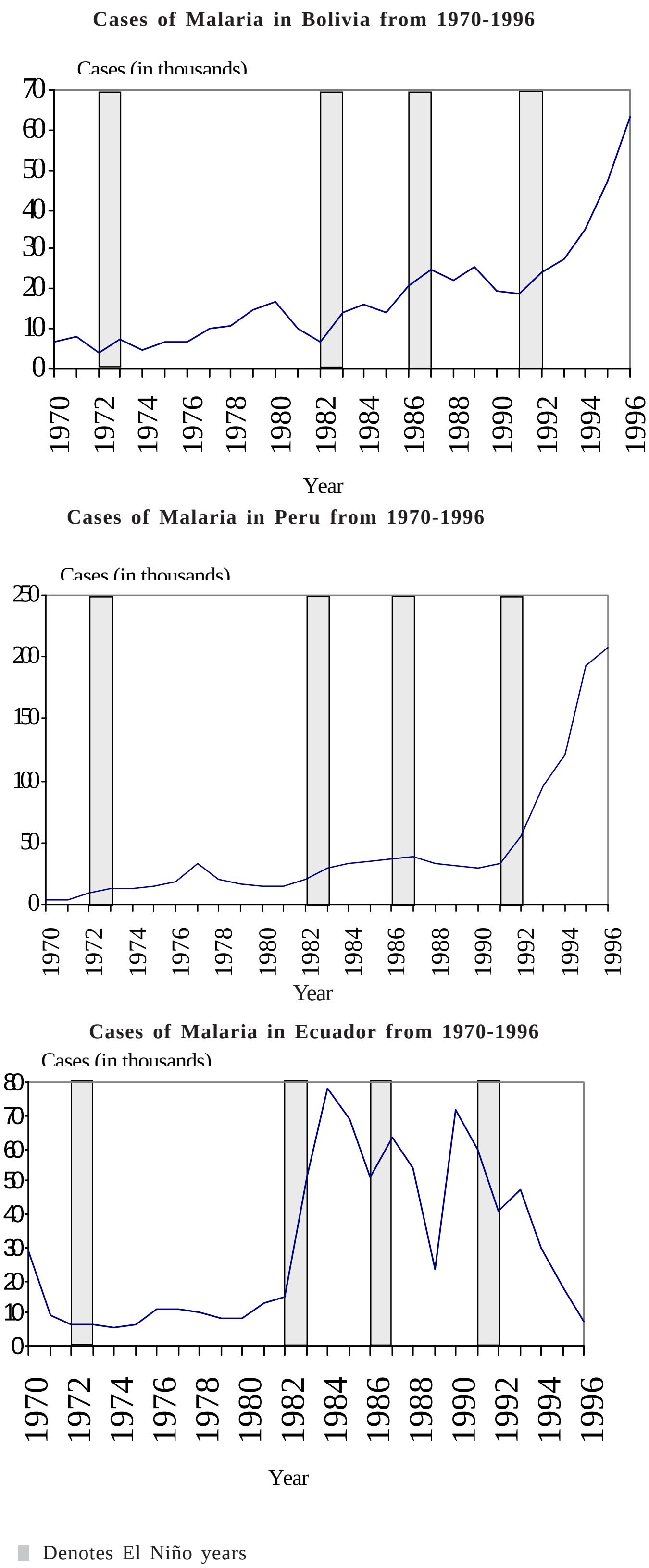
The potential risk of communicable diseases during El Niño is influenced not only by changes in the environment, but also by changes in population density, the disruption of public utilities, and the interruption of public health services. The risk of communicable diseases following an El Niño event is related to the endemic level of a disease in the community. This underscores the need for an effective on-going disease surveillance system prior to an El Niño event.

To date there is little definitive data directly linking El Niño to infectious disease transmission. The consequence of El Niño on disease transmission, however, must be considered within the context of disease ecology, the severity of El Niño anomalies, and social change. To underscore the difficulties involved in linking El Niño with changes in health conditions, data on several of the most important communicable diseases in the Americas are presented below.

The environmental models used to analyze scenarios of climate change and **malaria** transmission predict a worldwide increase in the disease associated with increases in temperature, humidity, and rainfall.

A review of data on malaria reported by each country in the Americas (1970-1996 PAHO malaria reports) shows that the incidence of this disease began to rise in all the countries in 1983 (Figure 1), with major epidemics in Bolivia, Ecuador, and Peru. However, the overall trend from 1970 to 1996 was an increase in the number of cases reported, while in El Niño years (1971-1972, 1976-1977, and 1991-1992) the incidence of malaria seldom increased over that of previous years. An increase in the number of malaria cases was observed in Colombia during the same period as in the rest of South America. It is known that, during this time, national malaria control programs in Latin America switched from a strategy of rigid eradication to flexible control. That alone could have caused the observed increase. Conversely, a good eradication program may have been masking the impact of El Niño in previous El Niño years.

Figure 1



The effects of ENSO on **dengue** are less well documented, but of increasing interest. Mosquitoes that breed in artificial containers spread this largely urban disease. Thus, in addition to climatic factors, changes in domestic water storage practices, brought about by disruption of regular supplies, will also influence patterns of transmission. As with malaria, it is difficult to prove scientifically that changes in the distribution of dengue are the result of El Niño events. In a preliminary study to correlate dengue with increased rainfall, no positive correlation between the two factors was found. In fact, peaks in dengue did not occur in El Niño years.

Aedes aegypti and *A. albopictus* have invaded new geographical regions due to the international trade in used tires and to road construction into rural areas. In the spread of dengue, the relative importance of the movement of asymptomatic dengue carriers and vectors into nonendemic areas and El Niño events or climate change requires further study.

In the Americas, the current **cholera** epidemic has been raging for seven years and, associated with a major El Niño, the number of cholera cases started to increase at the end of 1997. Currently, Peru is suffering from a major outbreak and for the first three months of 1998, there were 16,705 cases and 146 deaths. Bolivia, Honduras and Nicaragua are also reporting increasing numbers of cholera cases in 1998.

Cholera outbreaks have been associated with precipitation extremes—both droughts and floods. More recently, it was discovered that *Vibrio cholerae* is associated with a large range of marine life located on the surface of the water. *V. Cholerae* enters a non-active state in these organisms; when nitrogen, phosphorus, and warming conditions are favorable, *V. cholerae* reverts to a cultivable and infectious state. It has been suggested that the 1991 El Niño event, which warmed the ocean along the coast of Ecuador and Peru, accelerated the outbreak of cholera in this region.

Conclusion

The impact of El Niño on the facilities where disaster mitigation efforts were carried out was far less serious than in those where no such programs existed. PAHO will continue to provide technical cooperation to reduce the vulnerability of health facilities to all types of disasters, improve structural and nonstructural safety, encourage the health sector to incorporate mitigation measures in health facilities, and improve preparedness plans and programs.

When an El Niño event is forecasted, the following should be determined about the infrastructure of health facilities:

a) their condition during and after the event to assess whether they can continue to operate and the conditions and needs that must be met to guarantee their operation;
b) the capacity of the affected region or area to receive basic water, electricity, communications, and transportation services; and
c) the operating capacity available to deliver health services to the affected community and the ability of the community to access such services.

The projected impacts of El Niño on disease will vary with the manifestation of the phenomenon (flood, drought, temperature increase). Since El Niño serves to exacerbate existing conditions, the risk of communicable disease will increase in areas where the disease is already endemic, the health situation is deteriorating, and where there is overcrowding and disruption of basic services.

In preparation for this kind of events, countries should consider to:

- Prepare a checklist of regional risk factors. In order to forecast the impact of El Niño in different endemic areas, control programs should acquire a thorough understanding of how local vector species respond to climate variability, and how a population's immunity and nutritional status fluctuate over time.
- Organize a timely and effective epidemic response, malaria control programs need to include surveillance and epidemic control in their routine activities.
- Incorporate climate forecasting into existing disease surveillance, emergency preparedness, and disaster prevention and mitigation programs can help to lessen the health impacts of El Niño, the Southern Oscillation, and other extreme events.

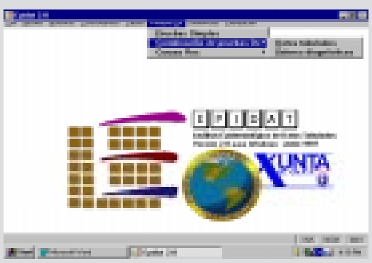
Available evidence indicates that El Niño events do affect health through the death, injury, and population displacement, as well as through their impact on the physical infrastructure of the health services. Given the biological plausibility that these phenomena might be associated to the occurrence of infectious diseases, more systematic data collection and better data quality is necessary to establish the extent of the association.

The Internet has facilitated information exchange on possible ways to counter with the health impact of El Niño events. Ministries of health should move to promote and improve Internet use, taking advantage of this low-cost medium to increase preparedness and reduce the vulnerability of the health sector. An improvement in radio and cellular phone communication in the Region gives health authorities better access to information generated at the site of El Niño events.

Many people in the Region are currently trained in the system for managing supplies in the aftermath of disasters; it is suggested that the countries strengthen their knowledge of the Supply Management Project in the Aftermath of Disasters (SUMA) system to improve and facilitate the management of humanitarian assistance.

It is necessary to conduct well-designed studies on the impact of extreme meteorological conditions such as ENSO events on human and animal health. Attention should focus on the vulnerability of health infrastructure and ecosystems to El Niño events, on how the incidence of disease responds to extreme climate conditions, and the need for the programs to adapt to climate-induced changes in morbidity and mortality.

Based on "*Repercusiones Sanitarias del Fenómeno El Niño*", document CE122/10 of the Executive Committee for the Directing Council of PAHO. Washignton, D.C., June 1998 and the Weekly Epidemiological Record, May 15, 1998, Vol. 73, No. 20. WHO. Emergency Preparedness and Disaster Relief Program, PED, PAHO. Division of Disease Prevention and Control, Communicable Disease Program, HCP/HCT, PAHO. Division of Health and Environment, PAHO.



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Epidat 2.1 is a computer software that targets epidemiologists and other health professionals who deal with tabulated data. Epidat was developed to complement other statistical packages that use databases and to offer a tool that facilitates and supports the teaching of epidemiology. This new multilingual version, developed to run under the Windows® environment, allows users to select the working language either from Catalan, English, Galego, Portuguese or Spanish. The Epidat 2.1 package includes the following modules: Standardization of rates Sampling, Agreement, Tables, Diagnostic tests, Inference and Prioritization. Epidat 2.1 is available free of charge in PAHO's Web page at the following address:

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Eradication of Foot-and-Mouth Disease in South America

Presently, Chile, French Guiana, Patagonia in Argentina, Suriname, and Uruguay remain free of foot-and-mouth disease, without vaccination. At the 65th General Meeting of the International Committee of the International Office of Epizootics (IOE) in 1997, the northwestern region of the Department of Chocó in Colombia and territories in Argentina and Paraguay were recognized by the IOE as free of foot-and-mouth disease, with vaccination. Finally, the states of Rio Grande do Sul and Santa Catarina in Brazil obtained the same recognition in 1998. Furthermore, rapid progress is being observed in the situation in other states in Brazil that have had no cases of the disease in over two years.

The geographical area free of foot-and-mouth disease covers an area of 6.3 million km^2, or 40% of the total land area of South America, where 1.5 million herds of cattle and 140 million heads of cattle are concentrated, including the states of Goiás and Mato Grosso in west-central Brazil.

The new health status achieved by these countries and areas has bolstered their trade, gaining the recognition of the markets of the United States and the European Union, which opened up to meat from Uruguay. Furthermore, the markets of Eastern Europe, the Balkan countries, and Malta have opened up to fresh and processed beef from Argentina, while Bulgaria has opened up to beef, goat meat, fresh lamb and mutton, and beef by-products from that country; the Czech Republic and Poland have opened up to fresh and heat-processed Argentine beef and raw and cooked by-products, and Sweden to all animal products permitted by the European Union.

At the same time, Argentina has signed agreements with China to export fresh boneless beef and other animal products. Sanitary regulations for the export of animal products have also been harmonized with those of Middle Eastern, Asian, and African countries.

In addition, the strategy of community participation in administering the livestock vaccination campaigns at all levels has contributed to greater collaboration between the public and private sectors and promoted the social progress of such communities by developing other areas for cooperation to boost the productive capacity of livestock populations and improve the quality of life of *campesino* producers.

Experience in co-managing the campaigns with the productive sector can be demonstrated by the creation of 370 foundations in the Argentine program, 19 departmental committees in Uruguay, 91 committees of livestock producers in Colombia, and 161 local committees in Ecuador. Similar activities are under way in Venezuela and are provided for in the program proposals of Peru and Bolivia.

The achievements and impact described above were the result of the careful planning and complex operations of the technical cooperation provided by the Pan American Health Organization/Pan American Foot-and-Mouth Disease Center (PAHO/ PANAFTOSA), which was incorporated into the Hemispheric Program for the Eradication of Foot-and-Mouth Disease (PHEFA).

In its 46 years of existence, PANAFTOSA has supported the implementation of programs to eradicate foot-and-mouth disease from the countries. Especially important has been the launching and implementation of the Hemispheric Information and Epidemiological Surveillance System for Vesicular Diseases, which has been adopted to monitor other zoonoses of social and economic importance. This risk-analysis methodology developed and applied by the countries and areas free of foot-and-mouth disease, especially in the Central American Isthmus and the Caribbean, has been useful not only to organize programs for the prevention of foot-and-mouth disease and other exotic zoonoses, but also to serve as a basis for guaranteeing safe trade in livestock and their by-products.

Technology development and transfer for the production and application of oil adjuvant vaccines for foot-and-mouth disease was one of the Center's most significant contributions. The extension of the periods of immunity achieved through this immunogen and its strategic application based on the systems for livestock productive and marketing facilitated the eradication of the disease. This was reinforced with the methodological and technical development of quality-control tests for the vaccine, for which PANAFTOSA continues to be the international reference.

The generation of new knowledge and the development of diagnostic techniques for foot-and-mouth disease and other vesicular diseases has been a hallmark of PANAFTOSA's scientific leadership through the research conducted, the results of which have been rapidly applied to prevention and control activities. They include:

1. Molecular characterization of the existing strains of foot-and-mouth disease virus in the countries.
2. The identification of monoclonal antibodies for specific epitypes of the foot-and-mouth disease virus to support diagnosis through mapping techniques.
3. The development of an ELISA test for diagnosing foot-and-mouth disease, applied in Argentina, Paraguay, Brazil, Colombia, and Venezuela, in collaboration with the Food and Agriculture Organization of the United Nations and the International Atomic Energy Agency (FAO/IAEA).
4. Trials with foot-and-mouth disease vaccines formulated without adjuvants, to be used in emergency areas.
5. Assessment of the level of induced antibodies for nonstructural proteins of the foot-and-mouth disease virus in animals immunized with commercial and experimental vaccines.
6. Standardization of tests to detect nonstructural proteins in vaccine preparations.
7. Increase in the production of reagents for the Enzyme Immuno Transfer Blot (EITB).
8. Development of an indirect ELISA method using recombinant 3ABC, 3B, and 3A proteins.

The political and financial support mechanisms to achieve the sustainability of national programs were supported by PAHO's various advisory and decision-making bodies. The Inter-American Meeting, at the Ministerial Level, on Animal Health (RIMSA), convened biennially by PAHO, in which the Ministers of Agriculture of the Americas participate, has supported the programs and PAHO to continue its technical cooperation with the countries. In addition, the Meeting of the Hemispheric Commission for the Eradication of Foot-and-Mouth Disease (COHEFA) gave greater impetus to the eradication process in countries of South America, with the participation of livestock producers. The South American Commission for the Control of Foot-and-Mouth Disease (COSALFA), which celebrated 25 years of operations, for which PANAFTOSA is the secretary *ex officio*, has provided technical orientation to the national programs by furnishing new knowledge and methodologies and examining and adjusting the management of local programs.

While celebrating the success of the countries that have achieved the goal of eradicating foot-and-mouth disease, one should not lose sight of the fact that countries such as Bolivia, Colombia, Ecuador, Peru, and Venezuela are still struggling toward that end.

Source: Pan American Foot-and-Mouth Disease Center, Division of Disease Prevention and Control, Program on Veterinary Public Health, PAHO.

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