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Epidemiology: Current Uses and Future Prospects[1]

Introduction

The Pan American Health Organization in collaboration with the Ministry of Public Health and Environment of Argentina, and with the full participation of the countries in the Region, organized an open-forum seminar to formulate and analyze ideas and initiatives on uses and future prospects for epidemiology in Latin America.

The purpose of the seminar was to review the current practice of epidemiology within the context of disease control, evaluation of health conditions and planning of health care services and to consider the implications such activities have on the progress of research, epidemiological training, and health care services development.

Current Situation

The most important epidemiological event in the Region has been the perception of changes in the health profile of the population. Although communicable diseases persist in most countries, chronic and degenerative problems of adults and the elderly, accidents, illness associated with the work place and environmental pollution are becoming increasingly more important. The situation that emerges is a veritable epidemiological mosaic combining problems characteristic of societies with relatively underdeveloped socioeconomic conditions and problems more prevalent in so-called developed societies.

In health care services, epidemiology has been used to develop surveillance systems geared almost solely to detecting disease outbreaks and unusual situations, so that control measures can be activated promptly, particularly against some communicable diseases. In many countries these systems have become passive case-reporting mechanisms that typically collect data at the local level and compile them at the central level. In general, these data cover only a segment of the population (usually dealt with by public services); their quality is limited by defects in diagnostic services; and they are not analyzed at the levels at which services are provided. The situation is aggravated by the multiplicity of case reporting forms, which are controlled, standardized, and supervised by independent, autonomous categorical programs. Even in sporadic instances where these data are analyzed locally, the information obtained

[1] Based on the Final Report of a seminar held in Buenos Aires from 7-10 November, 1983.

The working documents presented at the plenary sessions of the seminar in Buenos Aires will be published by PAHO in July 1984. Those interested in obtaining copies may write to Epidemiology Unit, Pan American Health Organization, 525 Twenty-third Street, N.W., Washington, D.C. 20037, USA.

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does not produce immediate action due to limitations in local administrative capacity.

At the central level, data thus collected, besides being of dubious reliability, are outdated as well. Much of the information is presented in statistical tables accompanied by little or no analysis. The extent of analysis of the health situation is generally limited to reporting national rates or indicators that do not reveal existing or potential geographic and social variations in each country.

In most countries morbidity and especially mortality data have been useful as a basis for setting national priorities. Analysis of these data has made it possible to identify risks or risk categories by specific causes that account for the highest incidence, prevalence, and mortality rates, and to relate them to age, sex, and residence. However, it is not yet possible to determine the precise magnitude of the health problems of specific social and economic groups. A leading concern is the proper selection of indicators that will facilitate a concise, comprehensive, and balanced assessment of health conditions in a community. Many of these indicators are chosen without a critical analysis of their implications and determinants.

An examination of the health infrastructure in areas where surveillance activities exist shows that, in most countries, health care services coverage is insufficient. However, the extent of this problem is unknown, as are the factors that influence the utilization or underutilization of health services by various population groups. As a rule, the characteristics of the population are unknown, which in turn hampers any assessment of their health situation.

The multipicity of health care service delivery agencies, the absence of coordination among them, and the lack of trained personnel are factors which further complicate the analysis and evaluation of health conditions and services at all administrative levels.

Another related aspect involves the need to assess available technology for disease prevention and the clinical and surgical procedures used in medical care. During the 1970s it was found that the adoption of advanced technology did not, in most cases, generate the same benefits observed in countries where the technology had been perfected. The blind acceptance and acquisition of technology—rather than knowledge—without considering its actual usefulness has been the rule rather than the exception throughout the Region.

Epidemiological research has not proliferated as desired and has been confined to isolated clinical and laboratory projects with little attention paid to population-based studies or research to improve health care services. The situation is aggravated by the fact that scientific research has been limited to universities and technical institutes with precious little participation by health care services. In addition a national research policy is often lacking and priorities are frequently distorted, sometimes in response to the particular interests of research funding agencies.

The situation described so far is closely related to inadequacies in training in epidemiology, in part caused by a lack of trained faculty but also due to a mismatch between the practice of epidemiology and the theoretical content of the courses. Many of the so-called practical courses in epidemiology are really geared to teaching infectious disease control principles and methods and include precious few fundamentals in epidemiological methodology.

The lack of access to scientific medical literature and the limitations of the health information which is on hand in medical libraries add to the difficulties experienced in training and carrying out research and hinder the overall development of epidemiology.

Future Prospects for the Development of Epidemiology

The previous overview suggests a series of approaches which require future development and which are detailed below.

Health Care Services

The practice of epidemiology should be reoriented to realize the discipline's full potential for improving knowledge, evaluation, and control of health problems and developing health care services.

To improve surveillance, collected data should be analyzed and utilized at the local level where decision making should also take place. Moreover, at progressively higher levels, analysis must also be carried out to contribute to the understanding of health problems, support decision making at each level and provide information for central levels where planning and standard setting take place.

Surveillance should be extended to such problems as malnutrition, chronic diseases, accidents, chemical intoxication, occupational problems and environmental pollution. However, since reporting systems used in epidemiological surveillance of acute diseases may not permit the acquisition of information adequate for understanding other problems, new data sources and mechanisms for data collection will have to be identified. New methods for analysis

will have to be defined to evaluate the preventive and curative measures directed towards these conditions.

The evaluation of health conditions should be expanded to include additional indicators such as the number of years of life lost prematurely and the number of cases which can be prevented under certain assumptions of effectiveness of disease control measures. Likewise, demographic analyses should consider particular characteristics of the Region such as the urban explosion, fertility variations and the composition of the population pyramid.

At higher levels in the health infrastructure, multidisciplinary functional groups with adequate representation by epidemiology should be formed for the purpose of promoting joint analysis for problem definition and program evaluation. These groups should work closely with particular programs. Their establishment becomes more important as the complexity and compartmentalization of the health sector increases.

To facilitate local programming and evaluation of health care services, data analysis should be based on the smallest geographical units and consider the structural characteristics of the health services and the distribution of population groups by living conditions. Programmed activities should be directed at solving the problems of these groups.

The analysis of certain indicators in terms of national averages can be complimented by analyses of health conditions of particular population groups stratified by types and levels of risk, including access by the population to health services.

The development of analytical capabilities will assist in defining more clearly what information is required and will generate increasingly pertinent and relevant analyses. Thus, epidemiology will enrich the process of health service planning and health evaluation, particularly in the areas of problem definition, priority setting, identification of alternatives and technological options and evaluation of strategies, programs and services.

Epidemiological Research

A continuing analysis of health conditions will reveal gaps in substantive and methodological knowledge that can not be filled by study of existing data. These gaps should become the object of research activities which should be undertaken by the health care service delivery agencies themselves.

All these elements should be taken into account when formulating national research policies, and identified research priorities should be compatible with those of the health sector. Moreover, creation of an appropriate infrastructure will be necessary to facilitate the implementation of these policies. The infrastructure will require mechanisms for coordinating the efforts of diverse univerity and health care service institutions and groups which, in turn, provide necessary resources and advice. The infrastructure should facilitate the development of more comprehensive, integrated research projects, with the necessary multidisciplinary support for collaborative studies on a national and international scale. At the same time, these mechanisms should contribute to the development of research capabilities in a proportion of health professionals, both in universities and in health care services, and the promotion of epidemiological research as a standard activitiy in health programs.

Under these general policies, special attention should be given to epidemiological and social research which focuses on the health-disease process as both a result and a determinant of the level of well-being and living conditions to which different groups in a society are exposed.

The priorities for specific research ought to be formulated in each country on the basis of an analysis of its own situation and be directed towards the solution of its most important problems. Nevertheless some general priority areas can be identified, for example the frequency and distribution of principal health problems and the biological and social risk factors that shape that distribution. These areas should include accidents, chronic diseases, occupational health and environmental pollution as well as the problems of the elderly.

The definition of health problems would be expedited if the health profile of a given group could be inferred from its living conditions. To validate this relationship, studies are required to relate the observed mortality and morbidity profile with variables which are easy to measure such as housing, employment and income levels.

Health care services research should be strengthened to include aspects related to coverage and how the population uses or fails to use these services, their accessibility and degree of acceptance and satisfaction and their relationships with different types of technical, administrative and funding organizations.

Research should focus special attention on measuring the effectiveness and efficiency of disease prevention and control measures aimed at the most

prevalent problems. In this sense, epidemiology must be extensively involved in the development of mechanisms for evaluating existing and new technologies used not only for health promotion and protection, but also for medical care where there is a tendency to adopt increasingly more costly technologies which are not always proven to be effective. Epidemiological research must play a central role in evaluating and choosing technologies in terms of effectiveness, efficiency, feasibility and practicality for implementation at different levels in health care services.

Much of this research will require new methodologies which should include simplified procedures and methods which can be incorporated into the activities of the health care services at different levels.

The majority of this research, especially as applied in health care services, should be multidisciplinary and carried out by teams composed of epidemiologists and specialists in administration, economics, sociology and other disciplines as necessary.

Training in Epidemiology

If the above viewpoints and recommendations for the uses of epidemiology in health care services and research are to be implemented, then training programs in epidemiology will have to undergo a profound transformation at all levels.

All health personnel should receive some training in epidemiology, and the characteristics of that training will depend on several factors including health and training policies, structure and organization of health care services and functional responsibilities of health care personnel. Manpower training programs must meet the needs of the health care delivery system in order to produce appropriately trained health personnel in general and epidemiologists in particular.

Training should include long range academic instruction as well as alternatives in continuing medical education and provide opportunities for in-service training, basic courses, refresher courses and epidemiology seminars for professionals with no prior training in this area.

Instruction in epidemiology and epidemiological methods should include a solid foundation which permits analysis of any health problem; it should allow for approaches to combinations of health problems in specific population groups and not be restricted to the traditional approach of teaching the epidemiology of a few specific diseases.

The training process should include different levels of complexity: a basic, practical approach to epidemiology for professionals in health care delivery; an undergraduate level for students of health sciences; general public health training; and, finally, specific training for epidemiologists with different degrees of specialization. The training process should include innovative techniques such as modular self teaching courses, the use of simulation exercises, and training-by-doing using course content based on actual situations in the countries themselves.

Within this context, the linkage between the training process and health care delivery should be improved so that professionals can "learn-by-doing". The epidemiological research which is needed in health services offers an excellent opportunity for strengthening this education-health care linkage since epidemiology acts as a unifying element for the body of health knowledge. This linkage should be used to improve epidemiological training through active participation in all levels of the health planning process, especially in defining health problems and possible interventions.

Greater coordination is necessary between ministries, schools, university centers and other parts of the health sector since these relationships are important for the development of epidemiology as a profession and, in particular, for the training of specialists, teachers and researchers.

The development of training programs with the features described will take resources beyond those currently available in national institutions. National resources should be mobilized and mechanisms should be developed for exchange among existing programs of teaching staff, instructional materials and educational experiences in general with the support and participation of international agencies.

Finally it should be stressed that the interdisciplinary nature of epidemiology enables it to transcend the mere aggregation of concepts and complementary actions and contribute to a synthesis of knowledge which is important for the understanding of health problems. Epidemiology should guide research, training and activities aimed at providing health services which are more effective, efficient and equitable for the populations of the countries of the Region.

(*Source:* Epidemiology Unit and Health Manpower Program, PAHO.)

Cardiovascular Diseases

Noncommunicable diseases—regarded until a few years ago as peculiar to industrialized countries—have been gradually displacing communicable diseases as the leading cause of death in the Region of the Americas. The reasons for this epidemiological actuality are very complex and have not been sufficiently studied as yet. However, the phenomenon is explained in part by the increase in life expectancy at birth, the progress made in controlling infectious diseases, the heavy migratory flows from countryside to cities, and the existence of risk factors primarily associated with occupations and lifestyles.

Within the group of noncommunicable chronic diseases, cardiovascular diseases rank first in the current health panorama of the Region of the Americas. Table 1 shows the mortality rates for heart and cerebrovascular diseases, as well as the percentages of total deaths accounted for by them, in selected countries around 1978. It may be observed that there is a slight correlation between the rates for heart diseases and for cerebrovascular diseases. Nonetheless, it is a noteworthy fact that the ratio of heart disease to cerebrovascular disease mortality is 4 to 1 in the United States, Canada, and Suriname and only 1.5 to 1 in Barbados and Chile. These differences suggest the importance of conducting epidemiological studies to delve more deeply into the characteristics and behavior of these diseases in Latin American and Caribbean countries.

Figures 1 and 2 provide sex-specific rates of mortality due to ischemic heart disease and hypertensive disease in the two most strongly-affected groups. The data corroborate that mortality due to these problems tends to rise with aging in both sexes and indicate the predominance of ischemic disease in males, a phenomenon especially apparent in the countries with the highest rates: Argentina, Chile, Trinidad and Tobago, and the United States.

As for hypertensive disease, the mortality does not indicate as marked a predominance among males; in fact, in Colombia and Cuba the rates in the 45-54 year age group are actually higher among females.

The sex differentials, with males generally predominant at all ages and for most diseases, are a little-studied phenomenon. Two factors have been considered in an attempt to explain these differences: women's greater capacity to adapt to conditions of environmental stress and a behavior by men which is less conducive to sound health *(1)*. It is possible that sex differentials in cardiovascular disease mortality are influenced significantly both by biological (especially hormonal) factors and by fac-

Table 1. Mortality rate per 100,000 population and percentage of total deaths due to heart diseases and cerebrovascular diseases,[a] in selected countries, 1978.

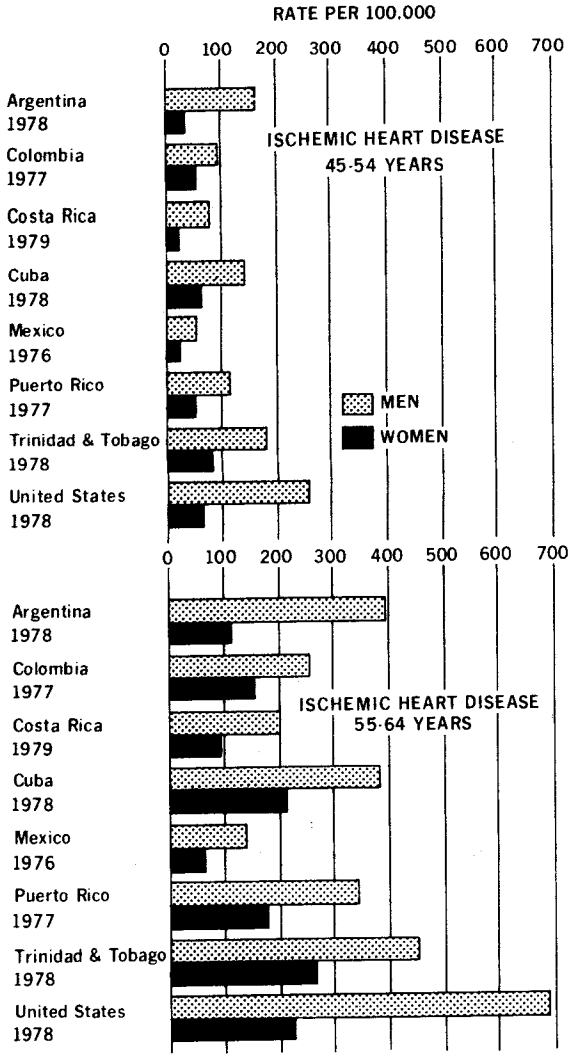
Country	Heart Diseases		Cerebrovascular Diseases		T_1[b] / T_2
	Mortality rate	Total number of deaths (%)	Mortality rate	Total number of deaths (%)	
Argentina	247,3	28,0	84,8	9,6	2,9
Barbados	173,5	22,4	112,4	14,5	1,5
Canada	247,3	34,5	64,6	9,0	3,8
Chile	92,6	13,6	58,6	8,6	1,6
Costa Rica	70,3	16,7	25,3	6,0	2,8
Cuba	169,2	29,8	53,6	9,5	3,2
Dominican Republic	41,7	9,2	18,3	4,1	2,3
Guadeloupe	129,1	20,3	50,3	7,9	2,6
Honduras	47,0	8,9	14,5	2,8	3,2
Nicaragua	60,7	11,2	19,1	3,5	3,2
Puerto Rico	163,8	27,3	51,7	8,6	3,2
Suriname	108,0	14,8	25,1	3,4	4,3
Trinidad and Tobago	162,3	24,8	82,0	12,5	2,0
United States of America	330,9	38,1	79,1	9,1	4,2
Uruguay	237,5	24,3	119,8	12,2	2,0
Venezuela	82,5	14,9	32,2	5,8	2,6

Source: Health of Adults Program, PAHO.

[a]Heart diseases (ICD-9 390-398, 402, 404-429; cerebrovascular diseases (ICD-9 430-438).

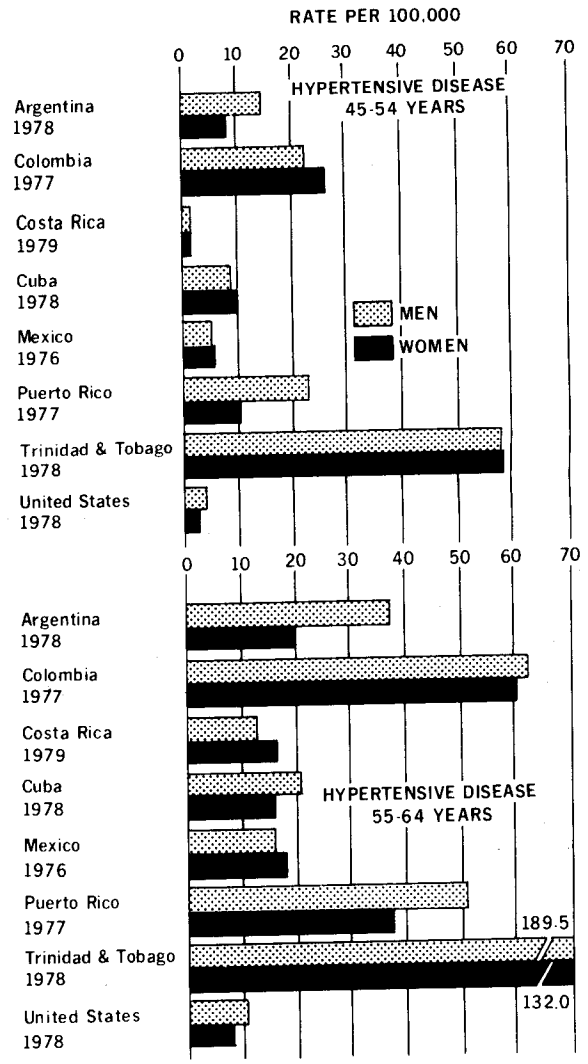
[b]T_1 = Mortality rate due to heart diseases.
T_2 = Mortality rate due to cerebrovascular diseases.

Figure 1. Death rates per 100,000 population for ischemic heart disease for the 45-54 and 55-64 age groups, by sex, in selected countries, around 1978.



Source: Health conditions in the Americas. 1977-1980. Washington, D.C.: Pan American Health Organization: 1982. p. 50. (Scientific Publication: 427).

Figure 2. Death rates per 100,000 population for hypertensive disease for the 45-54 and 55-64 age groups, by sex, in selected countries, around 1978.



Source: Health conditions in the Americas. 1977-1980. Washington, D.C.: Pan American Health Organization: 1982. p. 51. (Scientific Publication: 427).

tors associated with types and degrees of exposure to such risks as habitual smoking, ingestion of alcohol, occupational hazards, and stress, among others. In any event, this is another area that deserves to be investigated in the countries of the Region.

The differences existing from country to country with respect to mortality attributed to heart disease, and specifically to coronary disease, reflect a positive correlation with the countries' relative degrees of socioeconomic development; the same does not appear to hold true with respect to mortality from hypertensive disease, which has been clearly shown by population surveys to be more widely prevalent. Prevalence surveys in countries such as Brazil, Colombia, Chile, and Cuba, have revealed high rates for arterial hypertension. However, differences in mortality from country to country may be influenced by the use of different criteria in the classification of causes of death.

According to the data supplied to PAHO by its member countries, it was found in the 1970s in some countries that, while the trend of mortality rates in general was downward, the specific rates for certain cardiovascular diseases was upward. A case in point was the rate for ischemic heart disease mortality, which registered an increase in all the countries except Argentina, Canada, Chile, and the United States. Deaths categorized as due to "other heart

diseases'' are difficult to interpret because they may either be actually due to other diseases or may simply reflect a misdiagnosis of the cause of death; it is quite possible, however, that this category may include many deaths in which arterial hypertension and atherosclerosis played an important role. If so, the increase in this category would also reflect a greater risk of dying from these causes. Moreover, when the percentage distribution of the total number of deaths in the same decade in the various countries is analyzed, the increase in deaths attributable to heart disease is seen to be in the same range for all the countries except Canada, Trinidad and Tobago, and the United States.

Mortality information, while subject to limitations deriving from deficiencies in the records and classifications criteria, is nonetheless highly useful for the analysis of the health problems besetting a population. Analysis based on such data indicates that cardiovascular diseases are one of the major components of the health profile of several countries in the Region and, consequently, point to a need for deeper analysis of the situation. According to the approach proposed by the Government of Canada *(2),* the epidemiological model of determinants of diseases and deaths would consist of four basic areas: human biology, environment, lifestyle, and health care organization.[1] Applying this model, Dever *(3)* finds that the most important element in the occurrence of cardiovascular diseases in the state of Georgia, United States, is ''lifestyle''; accordingly, in an effort to reduce the damage wrought by such diseases in the United States, the greater emphasis should be placed on preventive programs involving changes in harmful behavior and on maintenance of healthy habits.

Despite the fact that conditions in the United States and Canada are far different from those prevailing in the rest of the Region with respect to the physical, economic, social, and cultural environment and with respect to the level of sophistication of health service systems, it would seem logical for developing countries to avail themselves of the information generated in developed countries on cardiovascular risk factors and the methods for studying them. Any viable experiments that contribute to primary prevention should be assimilated by them with a view to inclusion in their health programs. This assumes even greater importance because of the complexity of the many factors interrelated in the causation of cardiovascular diseases and their complications, which necessitates the use of a strategy based on an integrated approach to programming their control. This has been recognized by the World Health Organization, which has proposed the establishment of intercountry collaborative groups to foster the exchange of experience with integrated chronic disease control programs and has presented for discussion several study models for the initial phase of such programs, examples of which are the ones conducted in Finland, Thailand, the Lithuanian Soviet Socialist Republic, USSR, and Yugoslavia *(4,5).*

In its meeting in Washington, D.C., from 6-10 June 1983 *(6),* the Pan American Health Organization's Working Group on Programs for Chronic Disease Control discussed the current status of the programs for each of these diseases, as well as strategies for the programs aimed at controlling and preventing them.[2] The meeting's main conclusions dealt with: the importance of using the available information for determining the extent of the problem; the formulation of hypotheses with a view to gaining a better knowledge of the behavior of risk factors and the application of such knowledge in local programming and health care models; the need for the inclusion, at primary health care levels, of a program component consisting of activities for the prevention and control of priority diseases and of certain risk factors, especially for cardiovascular disease. Recognition was given to the importance of deploying the secondary and tertiary care levels in such a way as to provide support to the primary level in the management of patient suffering from heart diseases, especially those with cardiovascular problems.

Emphasis was placed on the need to spur additional research on factors contributing to this group of diseases in the various countries of the Region. Also stressed was the need to select priority risk factors (for example, the smoking habit and obesity), the control of which would be helpful in the prevention of various causally-related diseases. It was pointed out that assessing the impact of integrated chronic disease prevention and control programs would require the use of multiple-effect indicators in the case of coronary disease, diabetes, chronic respiratory disease, cancer, and various others.

[1]See PAHO *Epidemiological Bulletin.* 1983; 4(3):13-15.

[2]See PAHO *Epidemiological Bulletin.* 1983; 4 (6):15.

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(Source: Health of Adults Program, Health Programs Development, PAHO.)

Epidemiological Research in Tuberculosis Control

Introduction

Growing concern is being expressed about the fact that the tuberculosis control programs introduced in developing countries, now some 20 years ago, apparently fail to produce a noteworthy reduction of the problem *(1)*. Although it is generally recognized that these programs still have many shortcomings, there is a conviction that they will reduce transmission and thus cause a gradual decline.

The implied assumption that the trend of the tuberculosis problem is a suitable indicator of the achievements of a tuberculosis program perhaps should not be accepted uncritically. In Europe and North America a decline in tuberculosis set in long before the introduction of any specific antituberculosis measures. A pronounced change in the declining trend of the risk of infection was observed in the mid-1940s in many developed countries, with the discovery and widespread use of streptomycin for the treatment of tuberculosis. Whereas this no doubt caused a reduction in case-fatality, it should be noted that the ensuing reduction in the risk of infection also coincided with the upsurge in socioeconomic development after World War II. Then the rate of decline jumped suddenly from 3-5% to 10-14% a year, and this rate has been almost constant until now *(2)*. Some discrepancies in this pattern have been observed. In the Netherlands, the sudden change took place a few years before the discovery of chemotherapy; one explanation advanced is that the decrease was caused by the compulsory pasteurization of milk enforced by law in 1940 *(3)*. In Finland two abrupt changes were observed, one from 3.5% to 8.5% in the mid-1940s, and a second, doubling the rate of decline, to 16% in 1966 *(4)*. No plausible explanation has yet been found for this observation.

Before chemotherapy, certain measures were applied which probably had some effect in limiting the spread of infection, such as the early diagnosis by radiography and the isolation of patients in hospitals. Artificial pneumothorax might have had bacteriological benefits too. It is impossible to separate by retrospective analysis the epidemiological impact of these measures from that of the continuous improvements in the standard of living for the period. No estimates of the risk of infection are available before 1910, but the steadily declining mortality curve does not show any change attributable to the introduction of a specific intervention. For instance, in England there was a gradual increase in the annual rate of decline in mortality from tuberculosis during the period 1851-1946 of almost 1% to 2% but no modification in this trend was seen when the tuberculosis services were established and developed *(5)*.

In some developing countries, especially in Latin America, in the Western Pacific ridge, and the oil-producing Arab states, a modest annual decrease, in the rate of 2-5%, of the tuberculosis problem is probably occurring. These are countries with an intermediate level of socioeconomic development. Thus the attribution of all the credit for the decline to the tuberculosis programs, either in developed or in developing countries, is largely unwarranted.

A distinction must be made between epidemiological surveillance and program evaluation. Whereas

the trend of the problem will no doubt reflect any significant impact of the program, it certainly is unsuitable as a quantitative index of program performance, especially since problem reduction is not the only objective of tuberculosis control. The latter applies in particular to developing countries, where the basic programs are designed in the first place to prevent and relieve human suffering by providing BCG vaccination as well as diagnosis and treatment for patients demanding it. Although these programs may so far have had no measurable impact on the trend of the tuberculosis problem, they may to an appreciable extent have met their primary social objective.

Obtaining a reduction of the problem is essentially an associated objective of the current tuberculosis control programs, but an important one at that, and it is highly indicated that this question be studied amongst program conditions in developing countries. This means that adequate data must be gathered to reveal the dynamics and interactions of epidemiological events and the impact of control measures on the trend of the disease.

Measuring the Tuberculosis Problem

One of the first problems one encounters when examining the tuberculosis situation in developing countries is that there are only some rough indications of the magnitude of the problem, and that in actual fact little is known about the current trend and about the natural situation prior to the application of specific chemotherapy. The consensus that the problem is more or less stable in most developing countries is a general impression based on a few scattered observations.

In technically advanced countries the annual incidence, which usually is known from notifications, is an excellent indicator of both the case-load and the trend of the problem, but obviously this does not apply to situations in which the program is still expanding and the diagnostic services are still deficient both in quantity and quality.

The prevalence of the disease, measured in occasional surveys, provides an estimate of the potential case-load and therefore is obviously highly relevant to program planning, but it is not a suitable indicator for determining the trend in epidemiological terms. Prevalence surveys are technically difficult and costly.[1] A large number of prevalence surveys were carried out under WHO auspices in the 1950s in all regions but in particular in Africa *(7)*. In most individual countries the sample size was rather small, consisting of 2,000-3,000 persons living in about five or six clusters, and precise estimates therefore were obtained for the regions rather than for the individual countries. The practice of conducting periodical prevalence surveys has been maintained for a long time in the South East Asia and Western Pacific Regions (Korea, Japan, Philippines, Malaysia, Singapore, India, Burma, and Thailand) in spite of the technical difficulties and the high cost involved.

Longitudinal studies in large population groups to measure the incidence and its trend have scarcely been undertaken. The best known examples are those conducted in India, in Bangalore *(8)* and in the Chingleput area *(9)* in connection with the BCG trial. Such studies are extremely costly, technically difficult, require a long period of time, and have the inherent flaw of themselves influencing the problem.

Repeated surveys carried out in random population samples would not themselves influence the problem, but they would show merely the trend in prevalence, not in incidence, and thus rather reflect the program's performance than its epidemiological impact. Occasional limited prevalence surveys have been recommended to provide data for program planning and evaluation, but very often data collected in supervision and through the normal reporting system are ample to provide a sufficiently instructive picture of the state of the program.

As to surveillance of the tuberculosis problem in epidemiological terms, attempts could be made to measure the prevalence of infection at regular intervals in a specified (low) age group, which would make it possible to determine the annual risk of infection and its trend. The annual risk of infection, as revealed by tuberculin testing, was shown—in technically advanced countries—to roughly reflect the incidence *(10)*, but in developing countries this is not necessarily so, and its determination proves technically very difficult owing to the usually high prevalence of nonspecific tuberculin sensitivity caused by atypical mycobacteria and a high coverage of BCG vaccination in children.

This means that there is at present no reliable and easily applicable methodology for epidemiological surveillance and program evaluation in developing countries. This problem deserves a high priority in

[1] The cost of the 1980 Tuberculosis Prevalence Survey (Republic of Korea) was estimated to be US$147,000, i.e. 5.65 per head of the population sample (26,000) *(6)*.

WHO's tuberculosis research program. The most promising approach is to devise a more precise technique to measure the prevalence of infection in children in developing countries. A method has been proposed to determine the prevalence of infection in areas with a high prevalence of environmental mycobacteria *(11)*. The method also seems to be applicable to population groups given BCG vaccination at birth. This method could be tested and applied forthwith. In the long term, research on the isolation of specific antigens for skin tests will be promoted through the application of modern immunological methods, notably the use of monoclonal antibodies.

The Amenability of Tuberculosis to Control

The question of no decline being observed in many developing countries has had the attention of various expert groups. A variety of reasons have been advanced, all related to deficiencies in the application of the available technology. As regards the case-finding and treatment program, which is assumed to be potentially the most powerful tool since chemoprophylaxis is generally impractical, it should be noted that this is a concatenation of interventions. A maximum impact can only be achieved if every single element is fulfilled for 100%. As in practice there are often shortcomings all along the line, the final impact may be quite low indeed: if there are 10 elements, all fulfilled for 50%, the impact will be 0.5^{10}, or less than 1 *pro mille,* of what could be achieved.

Whereas a lack of decline is readily explained and advice on how to improve the performance of the programs is not difficult to find, explicit statements about the reduction of the problem that can be obtained with adequately implemented programs in third world countries have been either unsupported or vague. Surely, in developed countries, and actually also in some developing countries, a distinct decline is being observed which offers a promising outlook, but it is impossible to extrapolate these findings quantitatively. It had been observed that the tuberculosis situation in developing countries is different from that in technically advanced countries; for instance, in some developing countries tuberculosis is not mainly an urban problem but is also rife in rural areas. Still, it was generally taken that time-honored concepts about the transmission and pathogenesis of tuberculosis, and on the effectiveness of the various control measures, would equally apply in developing countries.

A generally accepted concept was that tuberculosis is refractory to control. The explanation was that disease, although more frequent shortly after infection, could occur at any time in later life and therefore would continue to occur in the large infected reservoir even if transmission of infection were interrupted. Observations in European countries appeared to confirm this viewpoint, and leant support to the underlying idea that disease was largely the consequence of endogenous reactivation of existing foci. A related technical observation was that the infectious forms of tuberculosis did not necessarily develop gradually, from milder forms. This suggested that in practice transmission could not be prevented by early detection and treatment of patients, but merely could be reduced by timely and adequate treatment of the detected infectious cases. Some support for this idea was derived from observations—in developed countries—that mass X-ray screening every 2-3 years only contributed a minor part of the detected case-load *(12)*.

These ideas led to the concept that a massive attack, limited in time, could scarcely have a lasting effect on the tuberculosis problem. More recent observations indicate that this may not be so. Some crash programs in eskimo societies produced a remarkable decrease in the incidence of tuberculosis, and this decrease was observed both in the noninfected population and in those already infected *(13)*. Also in developed countries a decrease in incidence has been observed in the infected populations when the risk of infection declined. Notably in England the risk of tuberculosis in infected adolescents is nowadays less than 10% of what it was in the late 1950s *(14)*. Clearly, these observations are incompatible with the view that endogenous reactivation is the only pathogenetic mechanism of post-primary pulmonary tuberculosis.

Observations made in the Prevention Trial, in India, confirm that in developing countries the tuberculosis problem may present itself in quite a different way than had been assumed. A surprising finding was that the large majority of new cases occurred not in newly infected persons but in persons who probably had been infected for the first time many years ago, in particular elderly men. This, and also the absence of protection from BCG vaccination, is compatible with most tuberculosis being caused by exogenous reinfection and not endogenous reactivation *(15)*. An incidental observation, which is of interest as regards the prospects of tuberculosis control, was that over a 5-year period the incidence de-

creased by about 25% in spite of the fact that case-finding improved consistently during the period *(16)*. The project provided extensive case-finding facilities, but no other treatment was made available than the standard regimens of one year's duration recommended by the national tuberculosis program.

Several of the more affluent developing countries have witnessed a decline in the tuberculosis problem, but invariably the coverage and quality of the health system has been quite high and extensive use has been made of X-ray and cultures for the diagnosis of tuberculosis, at least in the urban areas. And even then, the question of how much the decline is actually produced by the program and how much occurs as a result of general socioeconomic development is difficult to answer.

All developing countries, for social reasons, must give priority to affording immediate relief from suffering. Still, in formulating programs to attain the latter objective they would wish to select techniques and strategies that are also propitious to achieving a gradual reduction of the program and thus a durable social benefit. Any reduction in the risk of infection would have a relatively rapid effect on the incidence of childhood tuberculosis, a problem given little attention so far, which is not directly alleviated by the basic case-finding and treatment programs. Current programs notably appear not to eliminate intrafamiliar transmission of infection. Quantitative information on the magnitude of the problem in children, and on the epidemiological significance of infection in childhood, is badly needed.

The Impact of Various Control Measures

BCG Vaccination

It seems scarcely worth discussing this subject at a moment when serious doubts have been raised about the efficacy of BCG, but its potential epidemiological impact retains its interest. Extrapolating from findings in Europe, in particular from a large trial in England, it seemed that BCG vaccination not only could reduce considerably the incidence of tuberculosis in adolescents and young adults but also prevent an appreciable proportion of new sources of infection. Observations in other areas, however, did not substantiate this point of view. In the BCG trials in the United States, and very much so in the trial in India, new infectious cases of tuberculosis almost entirely occurred in the already infected population; during the first two and one-half years of the follow-up of the trial in India only some 4% of the cases of infectious tuberculosis had been potentially preventable. Thus, even mass vaccination with an effective vaccine could not possibly produce a significant immediate impact. A sustained vaccination program could produce an impact in the long run if the protection from BCG were appreciable and long lasting. This matter still needs to be studied, but it should be clear already that especially vaccination of the newborn will not prevent many sources of infection in situations where infectious tuberculosis is mainly a disease of late adulthood. The current priority is to investigate the protective effect of BCG vaccination against childhood tuberculosis in tropical and subtropical areas. Especially since young children do not benefit directly from efforts to detect and treat infectious pulmonary tuberculosis, BCG vaccination retains its potentially important role in the control of tuberculosis in children. A comprehensive program has been started by WHO to evaluate the effectiveness of BCG vaccination programs in young children and to identify and quantity factors and determinants that may influence the efficacy of BCG, including the characteristics of various strains of *Mycobacterium tuberculosis,* the role of exogenous reinfection, the host response, and environmental mycobacteria.

Passive Case-finding by Microscopy, Followed by Treatment

Currently this is the main control measure applied in developing countries. Microscopy fairly reliably gives a positive result if there are large amounts of bacilli in the sputum. Therefore it is considered that microscopy can discover, and subsequent chemotherapy will remove, the most important sources of infection. This in turn should reduce the risk of infection and thus the number of new cases arising among the noninfected. The question is—how much?

The matter appears to be an intricate one. In developed countries, with extensive case-finding activities and almost maximum treatment results, there has been a decline in the risk of infection in the order of 12-14% per year, of which some 7-9% have been attributed to the control program. The part played in this rather modest reduction[2] in the transmission of infection by the diagnosis of self-

[2]The reduction is considered very modest when compared with the effectiveness of other public health programs such as smallpox and measles immunization and chlorination of municipal water supplies, by which the transmission of infection is reduced by almost 100% in one year.

reporting smear-positive patients and their treatment is unknown. In developed countries many persons were treated on radiological evidence or when their sputum was positive on culture only. A significant proportion of these cases would have become smear-positive if left untreated, within a relatively short period of time. The removal of these potential sources of infection may have had a far larger epidemiological impact than that of the self-reporting established sources.

In the European countries disease used to occur relatively shortly after infection, so that a reduction in the risk of infection was soon to be followed by a reduction in incidence. Thus, the removal of sources of infection had a noticeable indirect effect. However, if a small reduction in the risk of infection is obtained in a situation where both the prevalence of infection is high and the interval between infection and disease is long, there may not be any measurable impact on the incidence for several decades.

Thus the effect on the epidemiological situation of passive case-finding by microscopy and treatment may be very small. It therefore appears of great interest to conduct prospective studies of the relative epidemiological merits of diagnosing and treating different categories of pulmonary tuberculosis, and to study the effect of introducing different case-finding strategies and diagnostic techniques.

Once an infectious case of tuberculosis has been detected it remains to be treated effectively if a source of infection is to be removed. In developing countries treatment often remains deficient, and this obviously further reduces the epidemiological impact of the program. In actual fact, the impact may be less than suggested by the proportion of patients cured; defective treatment may prolong the infectiousness together with the life of the patient. It would appear difficult to study this matter in isolation, but one attempt in Madanapalle, India, tended to show that an extended inefficient treatment program in fact produces an increase, both in the prevalence of tuberculosis and the risk of infection *(17)*, which seemed, in epidemiological terms, worse than not to treat at all. Surveillance of tuberculosis infection among contacts of patients may provide information on this matter.

Awareness and Motivation

An inherent weakness of the passive "case-finding" method is that it relies entirely on patients having to be aware of the fact that they are ill and being sufficiently motivated to seek relief at the right address. In these respects the situation in developing countries is on the whole much less favorable than it used to be in technically advanced countries. Only a fraction of the patients come to the attention of the competent health services. Moreover those who are positive only on culture remain undiagnosed until they possibly become smear-positive. Follow-up is therefore essential.

Increasing the awareness and motivation through health education, but also by providing adequate relief for respiratory complaints other than tuberculosis, may bring about significant improvements in the effectiveness of case-finding, especially if the quality of microscopy is high and can be complemented with culture examination. The development of primary health care, and in particular of active community participation, offers new prospects for achieving adequate levels of awareness and motivation. The returns of efforts in this field may be studied in comparison with those of further improvements in the specific control measures.

Smear and Culture Examination

Any diagnostic test discovers severe cases of disease more readily than mild cases. For this reason microscopy appears an acceptable technique in programs relying on passive case-finding, and probably also if a hard screening test is applied. Still, when the prevalence of tuberculosis among symptomatics is low, the method not only becomes impractical, but would also produce false results, as was demonstrated in Papua New Guinea, where among highlanders 1,400 smears would have to be examined to find one positive result, and the chance of this one being tuberculosis would be as little as 1.1% *(18)*. With increased awareness and motivation the effectiveness of microscopy as a diagnostic test will diminish as the prevalence of disease among those examined reduces, and the yield of case-finding actually may not noticeably increase unless a more sensitive diagnostic measure is introduced. It has been demonstrated that if health education shortens "patient's delay" in diagnosis, "doctor's delay" increases to the extent that the overall effect is negligible *(19)*. Studies on the sensitivity and specificity of smear microscopy as compared with culture examination need to be carried out under different program situations, preferably in connection with studies on the epidemiological significance of the various categories of patients.

X-ray Examination

In developed countries X-ray examination has been used for two distinct purposes: diagnosis and mass screening. Although not strictly pathognomonic, X-ray examination proved a suitable test in serious cases of disease, but in mild and early cases both sensitivity and specificity are much reduced. The latter results in a low effectiveness in populations where the prevalence is low, as was confirmed in mass screening in developed countries.

Diagnostic use of X-ray examination was not recommended as a priority for developing countries, since in passive case-finding approximately similar results can be obtained with sputum microscopy, which is much cheaper. Also mass X-ray screening was considered incompatible with a situation in which the first felt need of the population, i.e., diagnosis for persons with symptoms, and adequate treatment for patients, is not yet satisfied.

As a diagnostic facility at the referral level of the general health service, X-ray examination makes it possible to examine patients whose sputum is negative on smear examination, and thus to obtain further information in cases with unexplained chest symptoms. If adequate treatment facilities have been established at the community level, X-ray examination of high-risk groups would make it possible to discover at least a large proportion of the prevalence cases. Obviously the relative inefficiency of mass X-ray observed in developed countries should not be extrapolated to developing countries, but the matter should be examined under local circumstances.

Conclusion

Reviewing the epidemiological basis for tuberculosis control in the light of more recent observations, a number of approximations and plain gaps in knowledge appear to call for prospective quantitative epidemiological research into several issues. In particular the concept that control measures aimed at attaining the primary social target of control will also bring about a reduction of the problem, seems worth investigating. The relative importance of alternative measures will become relevant when developing countries will have the opportunity of extending control beyond the first priority stage, which is likely to occur with the widespread effective coverage of primary health care. Practical methods for program evaluation and surveillance need to be described if the situation in developing countries is to be duly appreciated in the future.

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(Source: H. G. ten Dam, Scientist, and A. Pío, Chief, Tuberculosis and Respiratory Infections Unit, WHO, Geneva.)

National Academy of Sciences (USA) Grants for Epidemiological Research and Evaluation

The Committee on Research Grants, Board on Science and Technology for International Development, National Academy of Sciences, supports research in developing country institutions on selected scientific questions of wide applicability. The Committee proposes to fund a small number of projects that seek, as a general goal, to apply and validate new or innovative epidemiological techniques for assessing public health problems in developing countries or monitoring the effectiveness of health interventions.

The Committee would be pleased to communicate with developing country institutions interested in conducting research to develop new and inexpensive epidemiological tools (e.g., survey or sampling techniques). Specifically, the chief objective of each project should be to answer a key methodologic question(s) about the performance of the new technique, compared to conventional ones currently in use. The outcome of the project should be an epidemiological technique that can be widely used in a timely fashion to: obtain reliable information about an important public health problem in developing countries; and/or monitor progress of a public health program in reducing morbidity and/or mortality from the problem in question. The Committee is especially interested in receiving proposals that seek to validate new epidemiological methods that could be routinely used to evaluate health outcomes and population coverage of disease control programs.

Grant funds may be used for support of scientists and technicians, purchases of project-related equipment, research expenses, and travel. Long-term training and purchase of vehicles should not be included. Appropriate safety procedures must be followed when working with pathogens.

Only institutions and public and private agencies in developing countries are eligible for grants. Institutions in middle income countries may participate if the proposal involves collaboration with other grantee institutions or contributes a unique scientific capability not otherwise included in the program. Collaborative work with scientists from industrialized countries is encouraged by the support of travel to grantee institutions for consultation and training in connection with funded projects. Grants average about US$100,000 for two or three years.

For further information and proposal preparation guidelines, send a letter with a brief description of the area of interest and proposed project objectives to: Dr. Michael P. Greene, Executive Secretary, Committee on Research Grants, BOSTID, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, USA.

Calendar of Courses and Meetings

International Course in Cancer Epidemiology

This course will be conducted in San José, Costa Rica, from 14 to 25 May 1984 under the auspices of PAHO, the Ministry of Health of Costa Rica, and the Costa Rica Social Security Agency. Its objectives are: to provide elements of statistical and epidemiological methodology to oncologists and other professionals associated with cancer programs; to promote epidemiological research on cancer and the publication of scientific reports in this field; and to improve the systems of epidemiology information on cancer in the Region of the Americas.

The content of the course will be as follows: cancer epidemiology in Latin America; cancer registries; basic concepts of descriptive epidemiology; analytical studies; cases and control groups; clinical trials and follow-up studies; use of computers in clinical and epidemiological research; specific sites (*cervix uteri,* breast, lungs, stomach, etc.); and methodology for the presentation and publication of scientific information.

Those interested in applying for PAHO fellowships to participate in the course should communicate with the Ministry of Health and the PAHO/WHO Representative in their respective countries.

Further information is available from: Dr. Orlando Jaramillo, Centro Nacional de Docencia e Investigación en Salud y Seguridad Social (CENDEISSS), Apartado 10105, San José, Costa Rica.

Intermediate Course on Epidemiological Methods Applicable to Health Programs Research and Development

This course will be held from 2 July to 3 August 1984 at the School of Public Health of Mexico. Professors from that school and from the Universidad Autónoma de México and the Johns Hopkins University School of Hygiene and Public Health will participate. The following subjects will be studied during the five weeks of the course: concepts, uses, and methods of contemporary epidemiology; fundamentals for statistical inference in epidemiology; characteristics of the different areas of epidemiological research, the principal types of study design and of the approach to risk measurement; epidemiological methods employed in observation studies; epidemiological methods employed in the study, prevention, and control of maternal and child health problems; and application of epidemiology in the formulation of health policies, planning of services, and research to evaluate the effectiveness of health actions and programs. A knowledge of the basic notions of statistics in epidemiology is required.

Requests for additional information should be addressed no later than 30 April 1984 to: Dra. Lucía Yáñez, Directora de Asuntos Escolares y Educación Continua, Escuela de Salud Pública de México, Avenida Francisco de P. Miranda No. 177, Colonia Merced, Delegación Alvaro Obregón, 01600, México, D.F., México.

Summer Courses in Epidemiology in the United States

The Johns Hopkins University School of Hygiene and Public Health will sponsor the second annual course, to be conducted from 18 June to 7 July 1984. The program includes design and performance of clinical tests; epidemiological methods for the evaluation of health services; epidemiological and preventive aspects of cancer and cardiovascular diseases; epidemiology of infectious diseases; introduction to biostatistics; methods in epidemiology; occupational epidemiology; and principles of epidemiology. A sound knowledge of English is required.

Further information is available from: Mr. Steven G. Warm, Program Coordinator, Graduate Summer Program in Epidemiology, School of Hygiene and Public Health, The Johns Hopkins University, 615 North Wolfe Street, Baltimore, Maryland 21205, USA.

The School of Public Health of the University of Minnesota will offer its 19th Summer Session for Graduates from 17 June to 7 July 1984. The program will include: fundamentals of epidemiology and biostatistics; epidemiology of infectious diseases; communicable diseases surveillance and control; hospital epidemiology and control of infections; cancer epidemiology; epidemiology of cardiovascular diseases; advanced statistics in epidemiology; occupational epidemiology; trauma epidemiology; and environmental epidemiology. A knowledge of English is required.

Further information is available from: Director, Epidemiology Summer Session, Division of Epidemiology, Room 1-117, Unit A, Health Sciences Building, University of Minnesota, 515 Delaware Street, S.E., Minneapolis, Minnesota 55455, USA.

The University of Massachusetts at Amherst and the New England Epidemiology Institute are sponsoring a course that will be offered from 19 July to 17 August 1984. The course will deal with the theory and practice of epidemiology, biostatistics, multivariant methods in epidemiological analysis, and the epidemiology of cancer and reproductive, clinical, environmental, occupational, infectious, and cardiovascular diseases. A sound knowledge of English is essential.

Further information is available from: The New England Epidemiology Institute, P.O. Box 57, Chestnut Hill, Massachusetts 02167, USA.

Training Workshops

Orientation and training in laboratory biosafety has been a major effort of the Special Program on Safety Measures in Microbiology (SMM). In order to develop a global network of biosafety expertise, a series of "train-the-trainer" workshops have been conducted and biosafety collaborating centers are being established. The WHO Regional Office for the Americas (PAHO) conducted the first course in June 1981 at the Public Health Institute, São Paulo, Brazil, the second in May 1982 at the Caribbean Epidemiology Center (CAREC) in Trinidad and Tobago, and the third in November 1983 at the Pan American Zoonoses Center (CEPANZO) in Argentina. A country-level course was held in July 1982 at the National Institute of Virology in Pune, India, under the auspices of the Regional Office for South-East Asia (SEARO) and the Indian Council of Medical Research.

An international workshop was held in June 1983 at the WHO Biosafety Collaborating Center, National Institutes of Health, Bethesda, Maryland, USA. Attending were 21 senior laboratory scientists

representing 16 countries and the six WHO Regions. The participants, selected by the Regional Offices, will conduct regional and country-level biosafety courses, participate in other laboratory-oriented training courses, and be available to provide assistance to individual countries and laboratories on request.

Expert assistance and advice on special biosafety matters may be obtained from any of the following institutions:

The Division of Safety (WHO Collaborating Center)
National Institutes of Health
Bethesda, Maryland, USA.

The Environmental Microbiology and Safety Reference Laboratory (WHO Collaborating Center)
PHLS Center for Applied Microbiology and Research
Porton Down, United Kingdom.

The Bureau of Infection Control (WHO Collaborating Center)
Laboratory Center for Disease Control
Ottawa, Canada.

National Institute of Virology
Pune, India.

Office of Biosafety
Centers for Disease Control
Atlanta, Georgia, USA.

Within the year five additional institutions will be designated as WHO Biosafety Collaborating Centers.

Advanced professional training in biosafety is available at the School of Public Health, University of North Carolina, Chapel Hill, North Carolina 27514, USA. Both master and doctor of public health degrees in biohazard science are offered in the program established in 1979. Information may be obtained by writing to the Director.

Additional information or assistance on biosafety is available from the Office of Health Technology Development, Pan American Health Organization, 525 Twenty-third Street, N.W. Washington, D.C. 20037, USA, or the Special Program on Safety Measures in Microbiology (SMM), WHO Headquarters, 1211 Geneva 27, Switzerland.

Diseases Subject to the International Health Regulations

Cholera, yellow fever, and plague cases and deaths reported in the Region of the Americas up to 29 February 1984.

Country and administrative subdivision	Cholera Cases	Yellow fever		Plague Cases
		Cases	Deaths	
PERU	–	–	–	*16*
Cajamarca	–	–	–	16
UNITED STATES	–	–	–	*2*
Texas	–	–	–	1
Washington	–	–	–	1

Note: Since the publication of the last issue of the *Epidemiological Bulletin* in 1983 (Vol. 4, No. 6), *Brazil* notified an additional 11 plague cases, 5 in the State of Ceará, 2 in the State of Bahía, and 4 in the State of Minas Gerais, for a total of 77 cases to date in 1983. *Peru* reported a total of 17 plague cases for 1983, all in the Department of Piura. Also, *Bolivia* revised its number of yellow fever cases, eliminating the one in the Department of Beni, for a total of 11 cases and 9 deaths due to yellow fever in 1983.

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION
525 Twenty-third Street, N.W.
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