Pan American Health Organization

PAHO/ACMR 12/7
Original: English
(Second draft)

TWELFTH MEETING OF THE
ADVISORY COMMITTEE ON MEDICAL RESEARCH

Washington, D.C.

25-29 June 1973

HEALTH RESEARCH IN LATIN AMERICA -

RECENT DEVELOPMENTS

May 1973

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Foreword

This volume is in certain respects a second edition of Science Policy in Latin America - Substance, Structures and Processes, a volume published by the Pan American Health Organization in 1966. However, this report differs from the earlier one in two respects. It concentrates solely upon health research, whereas the earlier report dealt in part with all of science. Secondly, this report concentrates on developments during the past five to ten years, whereas the earlier volume treated the earlier development of science in Latin America. Those parts of the earlier volume which remain valid and relevant are incorporated in this report, but most of the material is new and many of the earlier observations have been modified.

The Study Group wishes to express its gratitude for the opportunity to work on an important subject that both calls for concerted consideration by the entire Hemisphere and has tremendous potentialities for the betterment of mankind. The Group is grateful to the Pan American Health Organization for making the undertaking possible. In particular, the Study Group is indebted to Dr. Abram Horwitz, Director, and Dr. Mauricio Martins da Silva for initiating and supporting the effort. Finally, the Group wishes to record its gratitude to the Commonwealth Fund for providing the funds for meetings which were indispensable to completion of the work.

The study is based on discussions in all of the major countries of Latin America, where the matters discussed in the report were reviewed with a wide variety of people, such as professors, students, institute directors, government officials. A first draft of the report was carefully reviewed and criticized not only by the members of the group but also by the PAHO Advisory Committee on Medical Research, whose members are identified on a preceding page. The report was redrafted in accordance with their suggestions.

The central effort has been to synthesize observations made in specific countries, and the judgments of many informed people, into a report that would be primarily analytical rather than descriptive. The report is directed mainly toward observations and recommendations that may be helpful to those admirable leaders in the Latin American countries who have the difficult task of dealing in the real world with the problems set forth.

The Group has been conscious of the admirable dedication of distinguished scientists and men of affairs from all parts of the Hemisphere who have worked for years on the problem to which this report is addressed. Many contributed directly to the report, and many more made indirect contributions. The Group has also been aware of efforts to put into effect many of the measures again recommended in this report. The hope of the Group has been that its work can contribute to this continuing endeavor to lift and broaden the level of health research in Latin America.

As a personal note, I wish to record my appreciation for the work of my colleagues on the Study Group, the Advisory Committee on Medical Research and to all of those who took the time to discuss with us their accomplishments, frustrations, and aspirations.

Charles V. Kidd

I. INTRODUCTION

1.1 Unity and Diversity - General Observations

The Group believes that the generalizations in this report are valid, even though there are tremendous variations among the countries of Latin America. The reasons for this are as follows.

First, care is taken to limit the generalizations to those areas well known to members of the group.

Second, the inquiry deals to a great extent with government organizations and universities. Even with the amount of diversity that exists, the operating framework of government and the structure of most universities have a degree of similarity that greatly simplifies description.

Third, the inquiry deals with science -- and with a limited area of science. This too broadened the base of common practices, assumptions, and structures examined. The subculture of science is common to all countries that practice science. The attitudes of mind prerequisite to good science are common. The alternative ways of organizing science are relatively few, and their comparative merits have been discussed at length by competent people.

With respect to common and diverse characteristics, the combination of influences exerted over universities and intellectual life generally by Europe and the New World deserves special mention. Latin American universities evolved before independence /from the European tradition, and particularly from Italy and Spain.

Traces of these influences remain. However, a more important force has been the Napoleanic idea of a central state university designed to prepare professionals and not concerned with research. Both the strengths and weaknesses of universities are attributable in large part to this heritage. However, a strong trend of the past two decades, and one which is accelerating, is weakening of the influence of European culture and traditions, particularly in universities. Intellectual leaders scientists, engineers and including the bioscience younger people are rapidly forging an independent culture. In science,/this culture has been particularly since World War II ~~is~~ strongly influenced by the United States. English tends to be the universal language of science. In these respects, as in most others, the trends are not uniform.

1.2 Differences Among Countries

In spite of important common characteristics, there are wide differences in the actual state of development of health research in Latin America. Therefore caution must be observed in drawing universally applicable conclusions or in making general recommendations.

To provide a framework for discussion by separating countries into categories which have many common characteristics so far as health research is concerned, Latin American countries can be placed in two groups:

Group I

Countries with multiple centers of research

Argentina	Mexico
Brazil	Peru
Chile	Uruguay
Colombia	Venezuela

Group II

Other Countries

Bolivia	Guatemala
Commonwealth Caribbean	Haiti
Costa Rica	Honduras
Cuba	Nicaragua
Dominican Republic	Panama
Ecuador	Paraguay
French and Dutch Islands	

The eight countries in Group I together account for 70 percent of the economic product of Latin America. They account for about 90 percent of the resources -- people, equipment, buildings, operating funds -- devoted to health research. They have diverse and relatively large structures for biomedical research. Each has a fairly elaborate university system. In each there is a wide variety of investigation, both basic and applied. Their best laboratories are superbly equipped and often installed in excellent laboratory structures. Most of them have influential National research bodies although the funds available to these groups vary widely. Each of the countries finances all but a small part of its health

research from its own resources. In each of the seven there is a substantial group of distinguished investigators and a solid tradition of research. The links of the biomedical research community of these countries to the world scientific community are relatively diverse and strong. The points of scientific strength have survived political trumoil and economic instability so that a strong, continuing tradition of research is established. However, as will be pointed out later, economic difficulties and political turmoil threaten these traditions in some countries. These countries typically have ministries of health that are interested in research as a means of increasing the effectiveness of the health measures for which they are responsible.

The second group of countries is quite diverse, but alike in that they do not have a national structure for research characterized by more than one strong research center.

One special aspect of diversity needs an explanation -- the Caribbean area. The traditions, culture, and problems there are so different from those of Central and South America that generalizations in the report refer to this area only if there is a specific note to that effect. Within this second group, there are some countries which have individual investigators of international reputation. However, these countries do not possess the resources required for a relatively large and diverse research effort. In some of the countries, such as Guatemala and Panama, laboratories financed and largely staffed by international organizations or other countries account for almost all of the research in the country.

2. Why Health Research? What Kind? How Much?

2.1. Introduction

In this section, the report deals with issues faced by every country in determining what its health research[1/] policies should be. These issues are controversial, but the report states a broad consensus on major problems.

In the field of health, as in other fields, more is known about the cause and cure of disease than is being applied. Why, then, should countries with limited resources -- as is true of all the countries in Latin America -- devote part of their resources and part of their precious stock of highly trained manpower to a search for knowledge, when the urgent tasks are to use existing knowledge for the betterment of the people's health? Why not let more richly endowed countries produce the new knowledge, which can then be freely used to elevate standards of well-being? Among persons without scientific training, and among some dedicated public health workers, it is frequently held that biomedical research is a luxury underdeveloped countries can ill afford. Some students are opposed to the time devoted by the faculty to research, believing that the primary and main responsibility of the faculty lies in teaching.

Conversely, many scientists think that research is its own justification and that the only proper guide to research policy is "more" -- more money, more buildings, more equipment, more staff, more students.

The countries of Latin America have no alternative so far as the conduct of health research is concerned. They must support research, both basic and applied. The Advisory Committee on Medical Research of the Pan American Health Organization has usefully summarized the case for research in terms of short- and long-range goals:

> Adequate transfer of technology from abroad - and medicine is a technology - requires adequate selection and adaptation if inefficient, useless or even harmful technology is to be avoided. Selection can be discriminatory only when those who wish to import technology have a sophisticated background and valid grounding in basic science. Furthermore, many important local problems are of no interest to the developed world, and the research to deal with them must be done locally. This is why the countries of Latin America have no alternative so far as the conduct of health research is concerned. They must support research, both basic and applied. The Advisory Committee on Medical Research of the Pan American Health Organization has usefully summarized the case for research in terms of short- and long-range goals:

1/ See Appendix I for a definition of health research.

> The immediate purpose of supporting research in Latin America is to solve problems related to health in a manner which will promote human welfare.... The long-range goal is to promote upgrading of the community in its most human aspects through the cultivation of science. Indeed, science, if understood properly as a form of culture, is a means of eventually providing the whole community with an objective awareness of the proper context of man; it gives a holistic view of the universe, in keeping with man's intellectual nature; it will eventually provide a basis for mutual understanding; and it is in any case a proper basis on which to build education.*

2.2 The Significance of Basic Research

The conduct of basic research in the biomedical field is essential to placing the scientists of any nation in the stream of development of modern science. Research of this sort is required if any nation is to exist as a twentieth-century nation in the twentieth century. The conduct of basic research is essential to the development of scientists for the future, to the maintenance of a tradition of learning, and to the inculcation of a quantitative, critical approach among students. Basic research in biomedicine is required fundamentally by the values of science and alone not by the need to raise local health levels. These values of basic research and the need to sustain it are cited because this view runs counter to the philosophy of those who argue that relatively poor countries should not concern themselves with basic research.

A further reason for support of research was advanced at a meeting of the PAHO Advisory Committee on Medical Research in 1970, in the course of a discussion of metabolic adaptation and nutrition:

*PAHO Advisory Committee on Medical Research, Report of the First Meeting, 1962, Documetn RES 1/19, p. 2.

> "In countries with major problems of medical care and limited scientific traditions and research experience, a serious problem will exist in the attempt to apply the newly emerging scientific principles to clinical situations. The effective application of scientific principles requires the availability of a group of basically-trained scientists to be certain that the principle is not only understood to begin with, but also is being appropriately applied and critically evaluated. After all, the great value of a scientific principle is that if fully and critically understood, it will permit a practical application free of empirical considerations. Since the clinician may not in all instances be sufficiently well trained to comprehend, appreciate, and effectively utilize the full potential of all of the new developments in the basic sciences, it goes without saying that any commitment of a society to deliver effective medical care must at the same time accept a commitment to train and maintain a sizeable group of basically-oriented scientists."

But good basic research[1/] is not inherently superior to good applied research. Those engaged in it are not necessarily doing more significant or more difficult work. Basic research needs to be done on problems related to the practical problems of a nation, and such research should be given priority over basic research not so related. One of the most fallacious and destructive myths of science is the inherent intellectual superiority of basic research and of those engaged in it. Basic research, like applied research, can be unimaginative, trivial, and repetitive.

1/ Defined for this paragraph, as the National Science Foundation of the United States and other national research bodies define the term, as research where "the investigator is concerned primarily with gaining a fuller knowledge or understanding of the subject under study;" Such a definition relates to motives, and motives are different from findings.

Basic research, that is investigations dealing with fundamental phenomena which appear to have no direct and immediate use in terms of solving social problems, may in time be very important to the solution of practical problems. Deliberate efforts can and should be made to identify research areas that must be basically explored in a purposeful way if the solutions to practical problems are to be realized.

An important development in Latin America over the past decade, and one which has been accentuated over the past five years, has been the development of stronger links between basic and applied research, an increase in basic research derived from practical problems, a reduction in the sharp distinction between basic and applied research that formerly existed, and a selective increase in the prestige and status of health research -- basic or applied -- related to practical problems. Moreover, there is a consensus that a balance between basic and applied research should exist, and that applied research can not progress unless there is a foundation of basic research in progress.

A high degree of pragmatism should exist in deciding -- at least over the short run -- how much basic research a country should support. The pragmatic element lies in the support of the most talented people. Since few countries can support all fields of basic science, they can probably best select fields of emphasis over the shrt run by betting on good people--regardless of the fields in which they work--rather than by setting up abstract priority schemes in basic research. However, over the long run efforts can and should be made to encourage research in certain fields or toward basic problems of significance to economic growth. These efforts must be exercised skillfully and without coercion if they are to be effective.

More important than the division of research among fields is the total investments in research and the quality of investigations. The problem of balance, difficult though it is, is more easily dealt with than that of generating awareness of the significance of scientific inquiry and the need to expand national investments in this area.

2.3. Applied Research

Research applicable to health is an investment, not an expenditure. Moreover, this investment, together with education and health, is one of the most profitable a country can make. Latin American countries have not invested adequately in these fields.

It is often argued that since so much is already known that is not applied, further research by less developed countries is pointless or of low priority. This is a dangerous doctrine, which will imperil the future of any nation that takes it serious.

(1) Most techniques of health protection are not general-purpose techniques applicable in all countries under all circumstances without modification. The blind acceptance of diagnostic, prophylactic, or therapeutic measures without consideration of the effects of local circumstances can lead and has led to serious error.

(2) A questioning attitude, a willingness to put accepted doctrine to practical tests, and a preference for quantitative evidence derived under local conditions are all necessary to the fully successful adaptation of applied health measures. These are the attitudes that underlie applied research, and with such attitudes applied research will exist. The function of applied research is, in fact, to promote these attitudes as well as to produce data relevant to the solution of obvious public health problems.

(3) A flexible, inquiring, **critical**, technically competent approach both to existing practice and to innovations is necessary if countries are to recognize weaknesses in existing practice and to take advantage of innovations. A nontechnical, nonresearch society is incapable of taking advantage easily, quickly, and by its own efforts of technological progress--scientific or administrative --generated elsewhere.

(4) A group of people competent in research applied as well as basic and currently engaged in research is a prerequisite to the absorption and adaptation of new technology. Assistance from other countries can substitute for national capacity in this respect, but this is a short-range and not a long-range solution.

(5) Having a group engaged in research is an efficient way for a country to discover the existence of health problems of which it is not aware, or to measure correctly the relative significance of its health problems. This information is indispensable to efficient use of the resources available for the protection of health.

(6) A tradition of applied research and the widespread diffusion of research throughout government operations and universities is important to the effective operation of government itself.

Nevertheless, significant applied health research developed after basic medical research in Latin America. Why has this been the case?

First, the strength of the arguments presented above has not been adequately recognized.

Second, "efforts to strengthen" applied research in Latin America encounter philosophical and practical problems. From within the scientific community, the doctrine--in many respects a sound one--that the way to build science is to support points of strength militates against the development initially of a strong applied research effort. The doctrine of support of strength is fostered by assistance from outside Latin America, which tends to put existing abstract scientific excellence high on the list of criteria that determine eligibility for research support.

Third, basic research has tended to be academic research, and since most research in Latin America has its origins in universities the "basic" approach predominated.

Thus, social and cultural pressures have tended to give prestige and other rewards to basic rather than to applied research.

Fourth, /in economies that have tended to be agricultural and traditional, the actual area in which applied research would be accepted or used has until recently tended to be narrow.

Finally, applied research is relatively expensive.

Accordingly, the paradox that countries that urgently need science and technology as tools of development have been relatively heavily involved with basic research is understandable.

The situation is now changing, and applied research is more extensive and productive in Latin America. Research is no longer confined solely to universities. The research professional is replacing the scientific amateur. The recognized needs for applied research are increasing. The increasing self reliance and independence tend to foster applied health research. More sophisticated planning makes clear the importance of applied problems. Worldwide attitudes towards the social obligations of scientists and the social utility of science are partly generated in and **increasingly** affect Latin America. The **image of the basic scientist as the only scientist worthy of respect is giving way to the idea that the scientist most respected is a solver of practical problems.**

Finally, scientific progress during the past decade in particular has provided basic knowledge necessary for more effective research dealing with current health problems. National investments in health research therefore have a greater potential for problem solving than was true a decade ago.

2.4 Research, public health measures, and population growth

Beyond any doubt, the rapid increase in the population of many Latin American countries poses a grave threat to elevation of the levels of living. It appears highly probable, if not certain, that per capita real income and per

capita food consumption will actually decline over the next decade unless simultaneious efforts are exerted to expand the economic base, increase food supplied, establish better methods of distribution, and moderate the rate of population growth.

(It has been proposed that the following two paragraphs be deleted)

This prospective situation has led many influential persons to advocate that deliberate efforts to extend public health programs be discouraged and that little or no assistance be given to the development of such programs. The rationale of this position is that measures to improve levels of health, which tend to reduce infant mortality and to lengthen the life span, simply add to the number of consumers and tend to thwart the goal of reducing the rate of population growth.

However, deliberate refusal to extend public health measures is deeply immoral. Refusal to adopt measures that are known to preserve life and to reduce suffering amounts to a decision to deny a basic human right--the right to life and the legitimate hope of a life not dominated by physical suffering, weakness, and lassitude. Refusal to adopt public health measures amounts to adopting a conclusion and a course of action in a situation so complex that the predicted outcome may not occur. And the chosen course of action involves a decision to refrain from extending lives and from reducing suffering. Human beings have an inherent right to benefit as individuals from the fruits of scientific advance. This right transcends the right to deny the immediately beneficial application of knowledge because of the long-range social, economic, or political difficulties that may thereby be created. The considerations in this specific case are fundamentally similar to those existing when proposals are made to halt the advance of science and technology on the ground that these advances do more harm than good. And the answer is the same. Man should not be denied the right to think, to act, to explore, and to change. Denial of this right is the denial of a basic human goal--a goal more basic and more valuable than the attainment of tranquillity, prosperity, or physical well-being.

Apart from the fundamental moral considerations, which should govern apart from any practical considerations, denial of public health measures will tend to thwart rather than further a rational total policy of economic and social development and a rational policy with respect to population growth. A basic goal of all measures for economic development is to raise the quality of life. Elevation of standards of living tends to reduce infant mortality, extend the life span, and reduce the prevalence of illness. It is as irrational to forgo public health measures because they have these effects as it is to forgo all economic development efforts because they have the same effects. Admittedly, the effects of public health measures on population may be more direct and powerful than those of general measures for economic development. Moreover, the population effects of public health measures can precede rather than follow increases in the standard of living. However, these differences are quantitative, and they do not always exist.

Also to be taken into account is the fact that elevation of levels of health can increase the productivity of the population by increasing the physical vigor, alertness, and motivation of the labor force. The greater the degree to which the horsepower of an economy is manpower, the more significant can be the effect of public health measures on the economy's productivity. Such public health measures may include malaria eradication, the provision of water (preferably but not necessarily clean water), improved sewage disposal, nutrition education and the provision of a better diet, and medical services ranging from rudimentary mass measures to individual attention.

Finally, in relation to population control, the effectiveness of any set of measures will depend decisively on the existence of organized means of educating the population, on the provision of advice and assistance, and on the furnishing of birth-control devices. There is no more effective way of providing the surrounding circumstances essential to the effectiveness of large-scale birth-control measures than through a network of public health clinics. An organized service for

providing health services is not antagonistic but prerequisite to effective population-control measures. One of the tasks of high priority in population control is to investigate the optimum relationships among all the public activities involved. This includes investigations of social, economic, cultural, religious, and political factors that affect the accessibility and acceptability of population-control measures.

2.5 The current state of health research

Biomedical research in Latin America has in the past in many countries been stronger than other broad fields of investigation. Medicine has traditionally been a prominent and prestigious profession. Medical faculties have tended to be stronger than science faculties. The practice of medicine has until recently provided a stronger economic base for individual investigators than other fields of science had available. Accordingly, when assistance to the development of science was provided from outside sources, first by the Rockefeller Foundation, medicine became the natural focus of attention. Not only was this field relatively advanced, but medicine and biology were the sciences most obviously relevant to the solution of human problems. These influences gave research in biology and medicine a strong and early impetus. The lead became cumulative, since talent attracted talent and money attracted money. As a consequence, the biomedical sciences have been the strongest area of science in Latin America as a whole and in most of the countries individually.

However, an important development of the past few years has been the strengthening of research in fields other than health. The establishment of National research councils, and similar groups, has led to recognition of needs for balanced development of science -- particularly in the larger countries which have the required resources. Accordingly, while health research has become stronger in absolute terms, it has become in most major countries a smaller proportion of the total national research effort. This is a healthy development

the branches of
because of the interdependence of/science, and because all fields of science benefit when national attention is directed to expansion of the total effort.

Apart from the relative position of health research in comparison with other broad fields of research, there is the important question of the relative strengths of various fields of health research, and of changes over the past decade.

It is not possible to make a complete catalogue of the entire field of health research. On the other hand, it is possible to indicate examples of areas of investigation which are generally considered to be relatively strong and those generally considered to be relatively weak. More important than simple identification of the fields is an analysis of the reasons for strengths and weakness as a guide to action.

First, which fields are relatively strong?

One must first identify individuals, laboratories and institutes which consitute points of excellence, as contrasted with fields of excellence. The points of excellence are important in their own right as a way of setting levels of aspiration and as an affirmation that work as good as any in the world is done by Latin Americans. For example, the work of Houssay and Leloir on carbohydrate metabolism was of Nobel prize quality. Similarly, investigations in neurophysiology in Brazil and Chili have been of outstanding international quality, as has research on the physiological effects of high altitude in Peru.

Yet these fields of science have not been strong in the sense of having many good laboratories, which produce relatively large volume of good students and good science.

Genetics has been a strong field of research in Latin America, and the center of strength in this discipline has been in Brazil. This is an example of extraordinary impetus provided by an inspiring teacher - Dobzhansky from the United States - who in effect created in Brazil a generation of investigators who firmly established a research tradition.

Biochemistry has emerged as a strong field in a number of countries. Here there has been a fortunate combination of stimulus through international organizations -- most notably the Organization of American States, effective training of Latin American students in some of the best laboratories of the world, and effective leaders within a number of countries.

Both genetics and **biochemistry,** it should be noted, are relatively new disciplines in Latin America, and it may be that the absence of established professorial posts **of the traditional type** in these fields has actually been a positive factor in the development of these fields.

Nutrition is relatively strong in Latin America. There are many outstanding nutritionists of the highest international standing, and many strong research centers. Relatively strong support for nutritional research has come from international sources, from foundations, and from individual governments outside Latin America. This support was sustained over a period long enough to permit the training of mature investigators and the establishment of strong, stable laboratories. Partly as a cause and partly as an effect of regional strength, there is a Latin American Journal of Nutrition.

Now most nutritional research is supported by national governments. Nutritional research is perhaps the best example of a sophisticated blending of basic and applied research directed towards a major cause of disease and death in Latin America.

Some fields of research are clearly growing in terms of quantity and quality. One of these is reproductive physiology, which has been given a strong impetus from both foundations and international organizations. Their concern is linked to the long run significance of the population problem. **One encounters here the tension between the principle of guiding research towards problems of highest significance and the principle of selecting for**

support the most able investigators regardless of their fields of activity. There is no obvious solution of this problem. Both principles are valid and should be pursued simultaneously. Scientists tend towards support of merit; others tend towards support of important problems.

Immunology is another field of investigation which is becoming more significant. This is an example of an area of basic investigation which serves as the underpinning for many kinds of applied research.

Microbiology and parasitology are important and strong areas of research. These areas are particularly important because much of the research is important locality, and will not be supported as an adequate scale from outside sources.

Secondly, what fields of health research have not been relatively strong?

Certainly modern clinical research has not been as strong as laboratory research. There are many reasons why the clinical approach to medical research has not flourished. There has been a tradition that clinical research consists of description of unusual cases. The modern concept of linking laboratory and clinical research to search for scientifically verifiable phenomena has been rarely applied. This kind of research requires intensive and broad training, and persons with this background have been scarce. Moreover, clinical research is expensive, and often the costs must be borne in large part by hospitals which have no funds for research. The Pan American Health Organization has recognized these obstacles and has initiated a program to overcome them.

Epidemiology is a relatively underdeveloped field. It is true that sound and important epidemiological work has been a part of a number of investigations. These have included studies of comparative mortality rates in different cities, studies of abortions in different cities, studies of air pollution, and so forth. In addition, epidemiology has been taught as part of the curriculum for the master of public health degree. However, the discipline of epidemiology itself has not been a strong one in Latin America, perhaps because mathematics has not been strong, with very few exceptions, in Latin American universities.

Since sound epidemiological research is an absolute prerequisite to the effective design and operation of many public health programs, it may well be that the most effective approach is to continue to press for the necessary epidemiological component of public health programs. An example is the imperative need for epidemiological ground work in connection with the Trans-Amazon highway and the extensive colonizat on plans for the Amazon basin. A large multi-national effort is indicated.

Research in public health administration and public health practice has lagged behind laboratory research, and the relative position of such research has not improved over the past decade. Latin American physicians are typically trained to be practicing physicians. They are strongly attracted to metropolitan areas where economic, social, educational, and cultural opportunities are most plentiful. Departments of preventive medicine are often weak or non-existent, and there are only ten schools of public health. Public health measures are

administered by ministers of health. In some countries these ministers have proud traditions of accomplishment, including research. In others, however, the attainment of a continuing, high professional level of administration of public health has proved difficult and there has accordingly been little or no research. Another factor that may account in part for the relative lag in public health research is that this type of inquiry is strongly affected by local traditions and practices. Consequently, it is difficult to transfer experience from one country to another. Laboratory research, on the other hand, while affected by local conditions, is to a greater degree conducted uniformly throughout the world. Training in one country is relatively easily transferred and used in another country.

Nevertheless, research in public health has become both more extensive and more productive over the past decade. The countries where these efforts have been most effective include **Chile, Columbia, and Mexico.**

One special branch of study that should be encouraged is investigation of the efficiency of management of hospitals, clinics, and public health operations through the techniques of industrial engineering and operations research. Resources are so scarce that intensive effort to use them most effectively is indicated. Accelerated efforts along these lines by both international agencies and national governments are warranted.

Cancer research is not strong in Latin America, and this is evidence not of a weakness in the total structure but of a rational allocation of effort. Much cancer research is extremely expensive, and can better be left to those nations which can afford it. This is true of research in other chronic diseases. While a moderate amount of research in these fields in Latin America is appropriate, the existing patterns of emphasis should not be drastically shifted towards large programs of research in chronic disease.

as as it should be

Virology is not/strong in Latin America,/ in spite of the significance of disease of viral origin. The reasons for this are not entirely clear, but some apparent causes may be mentioned. First, modern virology is extremely sophisticated and requires equipment which is expensive both to purchase and to operate. Many lines of advanced research in virology can be effectively carried on only in an invironment where protein chemistry, immunology, and molecular genetics are strong. Often expensive animal facilities which require very highly trained technicians are indispensable. To a substantial degree, virology in Latin America has been carried on by investigators from the United States in laboratories not associated with local institutions, and this approach has not encouraged the development of Latin American virologists or laboratories. All of these factors have inhibited the development of strong research in virology in Latin America, **despite some isolated small groups doing research of good quality.**

Is this true and significant?
Should this be omitted?

3. Biomedical Research in a Cultural, Political and Economic Context

3.1. Fundamental Forces

Biomedical research can not exist as an entity independent of the cultural, political and economic development of the country or region where it is carried out. Only to a limited degree can biomedical research develop more rapidly than the society of which it is a part. In this chapter, the influence of these forces on biomedical research will be analyzed, with particular reference to recent years[1/]. Dr. Bernardo Houssay, in his frank and perceptive analyses, has noted some of these factors: lack of broad understanding of the nature of science, of the nature of training for science, and of the conditions necessary for the effective pursuit of science; diversity, individualism, and a search for personal prestige that tend to inhibit cooperation; the tradition of the inferiority of manual work; an approach to education that stresses description and definition rather than critical and skeptical conceptual thinking; a tendency to dogmatism; a failure to observe obligations to others and to rules in general; a tendency to give greater weight to friendship and family than to objective factors in making decisions. To the extent that such traits are common; they tend to militate against the development of science.

The following articles provide deep insight into fundamental aspects of Latin American culture that create difficulties for the rapid development of research:

Atcon, Robert, "The Latin American Universities," in Die Deutsche Universitatszeitung.

Garcia, Rolando, "The Latin American Universities," in Ruth Gruber, ed., Science and the New Nations, Basic Books, Inc., New York, 1961, pp. 230-237.

Houssay, Bernardo A., "El pasado y el futuro de la ciencia en la America Latina," Ciencia e Investigacion (revista patrocinada por la Associacion Argentina para el Progreso de las Ciencias), Febrero 1954, Vol 10, No. 2, pp. 52-60.

1/ The report will not deal with underlying cultural and personality traits that militate against the rapid development of science in Latin America.

Houssay, Bernardo A., "La libertad academica y la investigacion cientifica en la America Latina," Ciencia y Tecnologica, Vol 5, No. 19 octubre 1955, Departamento de Asuntos Culturales (Seccion Ciencia y Tecnologia), Union Panamericana, Washington, D.C.

Houssay, Bernardo A., "Importancia del adelanto cientifico para el desarrollo y prosperidad de las Americas." Ciencia Interamericana, Vol 1, No. 1, enero 1960, Union Panamericana, Washington, D.C.

Roche, M., Science in Spanish and Spanish American Civilization, in Civilization and Science, in Conflict or Collaboration? A Ciba Foundation.

Scherz, L. "El Camino de la Revolución Universitaria" Editorial del Pacifico, S.A., Santiago de Chile, 1968.

However, it is important to note the historical fact that the adoption of wise policies and the infusion of a powerful set of simple ideas can shift the quality of higher education and research in a nation over a short period. Modern graduate education was introduced into the United States, largely on the lines of the German tradition, between 1875 and 1900. Medical education in that country was transformed in two decades after the appearance of the famous Flexner Report in 1904. The development of graduate education in Latin America, discussed in grater detail below, is following the same general course. That is, training at this level is expanding at a rate much more rapid than other broad indices of development -- such as growth of enrollment in secondary education or in per capita income.

3.2. A New Generation of Leaders

Leadership in biomedical research in Latin America has shifted with a few outstanding exceptions to a generation which has reached maturity since World War II. This group has some common characteristics -- high intelligence, driving purpose, excellent training, high scientific attainment, and an urge to progress and to change. The process of selection for advanced education and training, and the obstacles to a research career, are such that those who come to the forefront are an exceptionally able and highly motivated group. The single-minded drive of the relatively small band of leading investigators found in virtually every country is awesome. These scientists typically possess not only mastery of their own field but a keen sense of the general deficiencies of science in their countries. They are often leaders in university affairs generally and in the social and political affairs of their countries.

One important factor of great significance, seen in country after country, is the strong influence of training abroad and the relative increase in the proportion of persons who have had part or all of their advanced education in the United States. This has been in part a historical accident.

World War II made it impossible during a number of years for Latin America to maintain its traditionally strong ties with the educational and cultural institutions of France and other European countries. The educated class was almost completely isolated from its usual contacts. As a consequence, the United States replaced Europe as the major site for the advanced training of Latin Americans both in the biomedical and in other sciences. They were esposed to a different system of education, with more freedom of action, smaller classes, informality between the professor and themselves, a high degree of independence in the prosecution of their research programs, and an opportunity of broadening their experience through collaborative programs. They worked on a full-time basis and quickly saw the benefits that accrued. On return to their respective countries, many of them have become leaders in teaching and research.

Particularly in recent years, there has been an increase in the sense of autonomy, independence and self confidence of investigators. While they typically have scientific colleagues and friends in Europe and the United States, and while many of their values have been formed by graduate education abroad, they have a strong sense of their own worth, their own obligations and of the importance of building strong science on an indigenous basis. This growing sense of confidence expresses itself, among other ways, in determined efforts to increase national investments in biomedical research as funds from outside sources have been reduced, and in resentment of perpetuation of a condescending or "colonial" approach by scientists from Europe or the United States. There is a growing consensus that science can be stable and fully productive only when the bulk of funds come from local sources.

The existence of this group of leaders is perhaps the most important single favorable force affecting biomedical research -- and, indeed, all research -- in Latin America.

Meanwhile, it would be misleading and ungracious to ignore the fact that the foundations for biomedical research were put in place ten to fifty years ago by the efforts of a very few talented individuals. They have often worked in a culture and an environment indifferent if not hostile to science. Funds for salaries, for equipment, and for supplies have often been inadequate, and developing laboratories have suffered vicissitudes as the consequence of political change. In the face of such difficulties, these heroes of science have not only carried on research but also have served as the prime advocates in the establishment of a scientific tradition and of government recognition for science. Typically the organization required for research has been the creation and the reflection of an outstanding man.

3.3. Stability and Instability

The most significant single factor inhibiting the healthy growth of science in Latin America is political instability. By instability is meant rapid changes of power at the top of government, and the consequences of these rapid changes on all major activities of society, including research. Rapid changes in university, institute or laboratory leadership, changes in levels of funding for research as a whole, rapid shifts in program emphasis, the imposition of ideological tests on individuals uncertainty for the future, and a sense of personal and professional insecurity all tend to erode the concentration and continuity that are essential to productive research. If these kinds of instability and uncertainty are present, the ideological values of a regime make little difference.

Conversely, a stable environment -- one which generates a sense of personal security and one which assures reasonable institutional continuity -- tends to favor research. In this limited context, the ideological basis for the government is unimportant. By a stable environment is meant not one in which no change occurs, but one which can absorb change without disrupting institutions.

It should be added that these paragraphs refer only to research. Instability and rapid change may be necessary to the attainment of human values that are more fundamental than research; stability may express the expression of more fundamental

values. However, temporary or permanent harm to research is one of the costs of political instability.

Economic instability, which is often a reflection of political weakness or instability, commonly leads to inflation. There is no doubt that inflation has harmed research in many countries by making importation of equipment or supplies difficult, by reducing the real value of salaries to the poverty level, by cutting the real value of governmental support and by undermining confidence in the future. However, political instability has been a more troublesome impediment to research than has inflation.

3.4 Economic Capacity

While few scientists have all the space, equipment, assistants, and funds they consider essential, there has been on the whole a steady expansion of resources for medical research in Latin America over the past few years. There are still many laboratories anadequately equipped by any standards, and there are some that have declined from earlier periods. But on the whole the space, equipment, and ancillary staff are better and more extensive than at any time in the past. Much of the improvement has resulted from assistance from outside Latin America.

As contrasted with the situation over the decade 1960-1969, Latin American countries (and also the Caribbean area) are now entering a period during which they will have to decide whether to support a substantial research effort from indigenous funds as a reaction to a general decline in outside support. In some countries, the decision seems to have been made. In Brazil where governmental support for biomedical research is rising rapidly, and this country is exerting greater efforts to expand research in all areas than is true of any other country. In Mexico, as another example, funds for biomedical research are increasing from indigenous sources, and there is relatively little dependence on outside funds. The same is true in Venezuela, which supplies more funds for research (in relation to the capacity of scientists to use funds) than does any other Latin American country.

In other countries, the situation and the otlook are less favorable. In Argentina, for example support for biomedical research in real terms has declined over the past few years. The same is true of Chile where the simultaneous decline in internal and outside support has had catastrophic effects on some laboratories.

In Uruguay, Peru and Colombia support has been roughly constant in real terms. In the Caribbean area, it remains to be seen whether the decline in outside support will be followed by an increase in indigenous support.

3.5 Financing of Universities

The countries of Latin America have, in the main, been so hard pressed financially that they have found it difficult to finance what they consider the paramount functions of universities -- the conservation and the diffusion of knowledge. Accordingly, the common assumption underlying the financing of universities is that government is responsible only for supporting the basic teaching function through the payment of faculty salaries and basic operating costs. This is partly a matter of lack of resources and partly a matter of an archaic view of the university's function. Additional research costs -- such as expenses for supplies, equipment, salaries of technicians, or experimental animals -- are generally not provided in the university budget. The faculty member is usually personally responsible for procuring funds to meet them. Sometimes local funds are available, but the custom of private giving to support research is not widespread. This has tended to generate reliance upon foreign sources, and to make the reduction of funds from abroad particularly harmful for university research.

Public funds for research typically flow to special research institutes (or to social security systems) rather than through the university budgets which are typically controlled by Ministries of Education. In historical perspective, a major step still to be taken in many countries is recognition, made concrete through the provision of resources, that teaching and research are inseparable in universities. In universities of developing countries research should be understood as a natural and essential component of both teaching and learning. So much the

better if special units with particular emphasis on research can be provided. But in no case should the situation be "research versus teaching." This point is made because, with limited resources available, there is sometimes the tendency to establish so-called realistic priorities -- in appearance only -- between the one and the other. Not infrequently one hears that "there is barely money for teaching" or that "for lack of funds no research is don." These phrases indicate that the concept of research -- in a very broad sense-- as integral to effective teaching is not universally understood or accepted.

The deeply ingrained tradition of governmental support for higher education and research and the absence of a cultural tradition of private philathropy tends to forestall the development of independent source of funds for biomedical research. There is no counterpart in Latin America of the German Volkswagen Foundation, or the English Wellcome Trust, or of the Rockefeller, Ford and other private great foundations in the United States. Private local foundations willing to contribute to biomedical research are still few, but in recent years their number has been growing quite promisingly in various countries. So, far, the pharmaceutical industry, which is rather powerful and rich in the more developed countries of Latin America, has given token help in many countries and a greater contribution, although quite limited, in others.

3.6 Size, Isolation, and Communication

Many countries are too small and do not have the wealth to permit them to establish large and strong research structures. Few things are more difficult than the maintenance of high scientific capability and enthusiasm in isolation. Research flourishes in a subculture of research and in a total culture that understands and values science. In a number of Latin American countries, the critical mass has not been attained. This means that many individuals work as individuals, in isolated groups, and not in the midst of a large, diversified group of scientifically trained people.

Such a system contains further inherent dangers. Since the number of persons

competent in any one field tends to be small, the self-regulating mechanism that operates in large scientific communities is weak or non-existent. This sometimes permits mediocrity to succeed. On the other hand, such systems tend to provide no haven for nonconformists. Rejection of the potentially productive eccentric -- or the authentic genius -- does not occur only in small systems, but it is more likely in small systems.

All these considerations raise the obvious point, discussed later in this report, that forms of international collaboration are imperative if each country is to use its resources most effectively and if the total resources of the Hemisphere are to be used most effectively for the benefit of all countries. Fortunately, in no field of science is the tradition of international collaboration among the American states so strong as in medicine and biomedical research. These are also the fields in which private foundations and governments have provided the most sustained assistance to Latin American countries. The nature of this collaborative effort is spelled out in the later section on organization.

As a final point on the effect of size, isolation can be productive by insulating investigators from scientific fads and by directing attention to local problems. But for isolation to be productive, special circumstances must exist. The investigators concerned must be excellently trained, well equipped, and well financed, and they must have reasonable access to the mainstreams of science through reading, visits of others to their laboratories, and travel.

The means of communicating in science are deficient in Latin America as in the rest of the world, but the consequences are particularly severe in Latin American because of scarcity of resources. As a rule, libraries are not rationally located so that they can be used most effectively by students and by those engaged in teaching and research. Precious library resources are often found in relatively inaccessible places where they are either unused or in effect the private property of individuals or small groups. Perhaps because of the rarity of books and journals, they tend to be viewed more as museum pieces than as tools to be used in the day-to-day work of learning, teaching, and exploring. The scarcity of books extends to

standard teaching texts and basic periodical resources.

The deficiencies in communication in Latin America are further emphasized by the scarcity of rapid, informal contact among investigators interested in the same field. The invaluable specialized "newsletter" circulated informally in the United States and Europe is virtually unknown in Latin America.

Finally, the network of journals that provides rapid dissemination of findings in advanced countries is not adequately available in Latin America. Funds to subscribe to the international journals are often not available.

Available resources are often used ineffectively to support local research journals. With few exceptions, the tradition of the local research journal is wasteful. The small periodical devoted to the publication of papers written by the local staff of institutes or departments represents more a cultural artifact than a serious addition to the world's mechanism for communicating scientific findings.

Fortunately, these problems are being vigorously attacked. The growth of the Regional Medical Library in Sao Paulo is a favorable sign. The growth of good periodical libraries in major laboratories is a good sign. However, much remains to be done. In particular, the establishment, effective editing and sound financing of Latin American (as contrasted with local or national) journals in the major health sciences would be an important forward step. Funds now used to support local journals would with rare exceptions be better used to purchase international journals or to finance Latin American regional journals.

4. Organization - Universities and Institutes

4.1 Introduction

Tremendous disparity between countries and rapidity of change characterize research in Latin America. No report can present completely the full scope of the activity, nor can it be completely up to date. Accordingly, the purpose of this and succeeding chapters is not to provide a full and up to date description but rather to present primary characteristics and the general direction of change.

4.2 The Contradiction between Freedom and Organization

Organization of research is imperative for a number of reasons. First, there are rarely, if ever, enough resources--money, space, people, equipment, supplies--so that each investigator can have all that he wishes. Accordingly, resources have to be shared by a process that the scientist, or all scientists combined, may influence but cannot control. Secondly, society places demands on science. Science is such a powerful tool for the solution of problems--including health problems--that society will use it. In less abstract terms, national governments urgently require attacks on such important problems as malnutrition, malaria, schistosomiasis, occupational hazards, air and water pollution, and venereal diseases. Funds, including funds for research, are provided by governments to attack these problems. These efforts are a means of allocating scarce resources, and particularly scientists, to problems that are important to society.

On the other hand, research is done by individuals who must be free if they are to be creative, and creativity is essential to productive research. Science is primarily self-organizing. That is, individuals are ultimately the source of new ideas, and science has a structure into which these new ideas fit in a way that extends the structure of science in a productive way. The scientist must be free if his contribution to the structure of science is to be most effective.

Thus, there are inherent contradictions between the two conditions required for research -- organization and freedom. For example, allocation of resources

represents, in a sense, a reduction in the freedom and autonomy of science, since the decisions on priorities are taken from outside science and not from inside.

These questions are not philosophical abstractions but the essence of a very practical debate. Decisions on such matters as the budgets of ministries and the relative effort devoted to laboratory and field research rest implicitly on the answers to the basic questions.

Although organization is often considered to be the enemy of science and scientists, many important objectives can be secured by scientists through organization:

(1) They can point out to governments the ways in which research is relevant and essential to national development.

(2) They can suggest policies on national issues, such as the significance of research as an integral part of advanced training in the sciences, the relative significance of various areas of research, and the terms and conditions under which government funds should be made available for research. In concept, such activities represent the means by which science exerts counterpressures on society. Without such counterpressure, the influence of demands from society is likely to be detrimental to science and to lead to a poor response by science to the needs of society.

(3) Organization is not only a means of exerting social pressure but a device for communication. Communication in science is an essential condition of productivity and freedom. Workers are most effective if they know what others have done. The free selection of areas of work lies at the root of the process through which scientists produce a rational, organized division of work. The effective operation of this system depends on information. Information is transmitted in science primarily by talking and by writing. The transmission of information in both spoken and written form is aided by the organization of science.

(4) On a national level, an organization for science provides a point of advocacy for this important activity and is particularly useful as a means of guiding external assistance along lines most consistent with national objectives.

Realism also dictates that organization can be the mechanism through which the efforts of scientists can be frustrated.

This chapter is devoted to a discussion of the forms and the effects of organization for health research, particularly in recent years. In this chapter attention will be centered, after noting the importance of the individual to the two most significant organizations for health research -- universities and institutes. The discussion turns in later chapters to other types of organizations important to health research -- national ministries and national research councils, and international organizations

4.3 The Importance of Individual Scientists

In the development of health research in Latin American countries, a central problem has been to pass from the stage of heavy or total reliance on individuals to a stage characterized by strong institutions that persist as centers of research while individuals come and go. Research is always the product of individual minds, and the growth of strong and stable institutions does not mean decreased reliance on the worth of individuals. Organization is worse than useless if it does not enhance the productivity and creativity of the individual.

Underlying discussions of specific form of organization are central questions:

How is it possible to sustain strong institutions, capable of producing excellent health research and excellent advanced students, after the outstanding founder has left?

How can the work of first rate health scientis be directed towards investigations of social importance without stifling their creativity?

Experience has indicated some answers to these questions:

(a) Diversity of opportunity and alternative organizations are needed. Health

research flourishes best when institutions with different objectives, sources of funds and styles of leadership exist. The larger and richer countries of Latin America provide this diversity in part within their own universities and institutes. The smaller nations must depend almost entirely on international cooperation and exchange of students and professors to provide this diversity. Only recently has exchange of people and information reached a truly significant level.[1/]

(b) One absolutely essential condition is the establishment of a strong teaching function as an integral part of research activities. It is through the incessant process of producing the next generation of investigators that continuity is assured. This teaching need not necessarily be a part of a university. Much of the best teaching in Latin America, particularly at advanced levels of science, is done in institutes. However, the university -- with all the weaknesses that have sometics characterized this human institution -- has proved over the centuries to be the most effective device invented by man for the maintenance of an intellectual tradition, for the preservation of the intellectual heritage of mankind, and for the extension of knowledge.

(c) Maintenance of the momentum provided by individual leaders in science can be assures only if there is conscious recognition of the problem of continuity and survival. The concept that teaching and research at advanced levels are different aspects of a single process must be deliberately fostered. Research institutions -- institutes, university faculties, or whatever they may be -- that have not been strong centers for the production of new investigators have tended to become sterile, to shift from research to various kinds of service responsibilities, and to lose their status as strongholds of intellectual excellence. Conversely, those institutions that have sought out and fostered the development of outstanding students have thereby contributed to their own continuing vitality.

A practical consequence of these points is that research institutes and universities that are outstanding centers for the production of scientists as well as of research should be amply supported by governments. Conversely, any institution that purports to provide scientific training but does not simultaneously

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[1/] See Section 7 for a description of the mechanism for these exchanges.

serve as a site for research is incomplete and should be helped to fulfill its total mission. Similarly, deliberate pressure to engage in advanced training should be exerted on research institutions that do not do so.

4.4 The University - Strengths

The skeptical, inquiring, free, challenging, factual, quantitative, experimental way of approaching problems in basic or applied science or in any other field is the characteristic of science that gives it its immense power. This set of values characterizes societies in which science is strong. In contrast, the search for revealed truth, ultimate reliance upon authority, and faith in formal logic and rhetoric characterize societies in which science is weak. Acceptance of change, rather than the continuation of the status quo, is one of the basic psychological shifts that must come about if traditional societies are to develop effectively, for without change there is no development. The attitudes necessary for research -- basic or applied -- are those that lead people to accept and deal with change.

Universities should be powerful institutions not only for setting and preserving, but also for changing the basic values of societies. They are conservative institutions with radical functions. Societies must rely heavily on universities as agents of change, and as a means of introducing and fostering the idea of change as the norm. Their effectiveness in this role often gets them in trouble with governments; their ineffectiveness in this role often gets them in trouble with students. If universities are to be effective in this role, they must have a research tradition and a research approach. This is a fundamental observation the significance of which has been seen throughout the world: "The function of research in the university is to ensure that the student learns from one who is in the habit of learning, that he learns a method and an attitude taught by example. Its functions in the country are first to add to the country's relevant knowledge of its environment, and next to add to the general store of human knowledge what can best be gleaned from that country by appropriate local methods. Research which performs

either of these functions should be undertaken and published, regardless of whether it would be appropriate to undertake it or publish it elsewhere. A research tradition will produce the facts and the national planning based on facts which can make the best use of whatever trained people there are, at any standard; but people with no skill in exploring new methods, trained to a high technical standard appropriate to another environment, may merely be frustrated by lack of resources which they feel they need.[1/]"

This view of the general significance of research as a means of establishing a point of view, an attitude, and an approach to the solution of problems is fundamental. It is for this reason among other compelling considerations, that reserch in Latin America should not be considered esoteric or as in competition with resources for development.

Most health research in universities is conducted in medical schools. They have been strongly affected, like the universities as a whole, by the rapid rate of increase in the university-age population, by the emergence of a more numerous and powerful middle class in many countries, and by the accompanying pressures to increase tremendously both enrollment and the number of professional schools. Thus, in the middle of 1960, for a population of approximately 202.5 million there were 88 medical schools in all Latin America; by early 1964, there were 108; and by 1973 there were.....

Although it has been found extremely difficult to introduce major reforms in the traditional pattern of the well-established schools, such changes have been brought about in some of the newly formed schools. In the Faculty of Medicine of Ribeirao Preto of the University of Sao Paulo, established about 12 years ago in a rural area in the interior of the state, the entire faculty, preclinical and clinical, is full-time. This medical school has its own hospital, completely staffed by full-time personnel. The University of Brasilia also has a modern

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1/ Silcock, T. H., Southeast Asian University: A Comparative Account of Some Development Problems, Duke University Press, Durham, North Carolina, 1964, pp. 158ff.

structure, and extensive changes are being made in the structure of the University of Brazil in Rio de Janeiro. In Venezuela, the new University of Oriente, in Ciudad Bolivar, is experimental in nature. All the students there are required to take two years of basic courses (except premedical students, who take only one year) before entering one of the faculties. Members of the staff of its Faculty of Medicine are all full-time and are carefully chosen for their research interest as well as for their training and teaching ability. The faculty also has its own modern 400 bed teaching hospital, in which a great deal of emphasis is given to community health. Where research-minded people cannot be found among Venezuelan nationals, the school is hiring foreign staff members.

The University of Valle in Cali, Colombia, is another institution in the forefront of development. The medical school in Cali is strong in breadth and in depth. With substantial aid from the Rockefeller Foundation and with outstanding leadership, this medical school has become in many respects a leader for the Hemisphere.

In Argentina, new private universities are geing formed to try to bring about necessary and sought-after reforms. One of these, the University of the the Saviour in Buenos Aires, started functioning in 1959, under Jesuit auspices, as soon as the law that expressly forbade the establishment of private universities was changed. Again in Buenos Aires, a group of clinical researchers, who had formed a Center for Medical Education and Clinical Investigation (CEMIC) in 1958 in one of the hospitals under the Ministry of Public Health, have successfully raise funds from private sources to build a hospital and hursing school that it is hoped will serve as a standard for other hospitals and for fine postgraduate training. Unfortunately, funds have not become available on the scale that was hoped for and the accomplishments of the institution have not been as broad as the founders expected.

In Chile, the Institute of Sciences was established in 1962 as part of the

later it became the Faculty of Sciences.
University of Chile to train basic scientists./ Its staff was carefully selected from many of the already existing faculties, and all are on a full-time schedule. The objectives, as given in the charter, were to stimulate studies and research in various fields of science and to provide teaching and training that would lead to academic levels in science with which to improve higher education. It was hoped that students graduating from the basic course will either continue for their M.S. or Ph.D. or enter one of the other professional schools of the University. It was expected that in relatively few years the Institute would graduate high-caliber personnel in adequate number to assume positions in faculties throughout the country. In practice, most of its effort has been devoted to provision of basic training for students later studying different professions, although it has also trained scientists at the postgraduate level. However, one of the major disappointments in the recent development of health research in Latin America has been the widespread decay of health research in Chile as a result of economic difficulties and political instability.

Biomedical research is also conducted in faculties other than those of medicine. It is interesting to observe that schools and institutes of agriculture and animal husbandry in many countries carry on research of high quality and devote their efforts to problems of practical importance to the nation. Some possible reasons are evident. The first one is that agricultural research usually has high governmental priority since those who influence or make political decisions (including funding of research) frequently consider agricultural research to be more relevant to economic progress than research on health and in this they may often be correct. The agricultural and veterinary schools are relatively new. They are typically less bound by tradition. A larger proportion of their staffs have been trained in an environment in Europe or the United States that places high value on the practical applications of research. Medical education is often almost totally oriented toward clinical medicine and private practice rather than toward research and service, although it is pertinent to observe that typically a high proportion of the faculties of schools of veterinary medicine have been trained in medical schools. Schools of veterinary medicine and agriculture, because they tend to be located in the provinces rather than in capital cities, are freer to concentrate on their essential tasks.

4.5 The University - Weaknesses

Unfortunately the ideal view of the university has not always represented the actual state of affairs. Young people have often been frustrated by lack of opportunity. Some professors have discouraged research. The idea that the university has obligations to the society which supports it has often been weak. Political instability has hampered research in many universities. Accordingly, as the report notes later, many countries have had to develop research institutions outside universities.

Throughout Latin America, there have been long continued efforts to change some wide spread characteristics of universities which have, to lesser or greater degrees, impaired their ability to perform the functions which they claim as their unique role in society. The efforts to change have engendered bitter political, ideological and personal struggles. The entire problem has been made much more difficult because at times in many countries the university has been the only institution in society through which general political dissent could be effectively expressed.

The list of deficiencies that have existed at some time in some universities is rather long:

(a) Absence of graduate training.

Graduate training in arts and sciences has not been until recently a function of Latin American universities.

The establishment of graduate studies leading to the Ph.D. degree is one of the most significant developments in universities in recent years. Indeed, the idea of graduate study has become so popular over the past five years that many universities have offered graduate work before their faculties have been adequate in breadth and depth to provide sound graduate work.

(b) The rigidity of the often outmoded curriculum is a common problem

(c) Teaching by lecture and learning by memory have been common.

(d) Laboratory work has been deficient and in some universities absent in science courses.

(e) Organization of instruction based on chairs that are, so to speak, the

incumbents' private property for life imposes obstacles to modernization of the curriculum, to cooperative teaching among the various disciplines, and to the development of younger people. The title of "Professor" is still extremely important, especially in medicine. Respect for the authority and power of the professor has been fostered in some universities to the point where creative thinking, challenge to authority, and intellectual competition have been discouraged. In Latin America the power inherent in the title has sometimes been abused. For example, it has been used at times to augment private incomes, a practice not unknown in other parts of the world.

(f) The organization of many universities is rigid and compartmentalized by faculty. Traditionally, in Latin America, each of the major faculties or schools of a university has set up its own department in all relevant disciplines, duplicating similar departments in other faculties. Thus, biochemistry has been taught in the faculties of arts and sciences, dentistry, pharmacy, and medicine. Students have been required to take the particular course given in their own faculty, even if it was inferior to the same course given in another faculty. This has created inordinate expenses for duplication of facilities, equipment, and staff in institutions already lacking adequate funds. It has also tended to hamper the development of strong points in science. The structural changes necessary to reduce the self-sufficiency of the faculties is a major object of university reform, and the requisite adaptations have been made by many universities.

(g) The prevalence of part-time teaching, a special aspect of the "multiple-job" mode of employment of many professional people in Latin America, has had serious adverse effects on the quality of teaching in many universities. The salaries paid to part-time professors have often been a token. This system was rational in earlier years, when the only practical means of obtaining faculty was to rely on the part-time services of people engaged in the practice of various occupations and professions. However, it is clear that today research and teaching of high quality require full-time dedication. Biomedical research in Latin America has until recent years been pursued by the very few persons with professional prestige,

who are usually situated in institutes either associated with or apart from universities. Adoption of the full-time system is a major prerequisite to full professionalism in the faculties of universities.

The idea of a full-time career in research and teaching is relatively new in Latin America, and the idea has been translated into practice in comparatively few places. The career question is closely linked to the prevailing system of prestige and awards. Recognition is often as important as adequate salaries. Only recently has the scientist in some Latin American countries been accorded the standing given to physicians, lawyers, and generals. In this connection, it is pertinent to note that the recently announced Latin American analogue of the Nobel Prize has been named after the recent Bernardo Houssay, the most eminent scientist in Latin America, and an investigator in the bio-sciences. The OAS which established the award, chose Dr. Hurtado of Peru as the first winner of the $30,000 prize. Dr. Hurtado is prominent in the field of high altitude physiology. Such events as these are important in elevating the status of scientists in Latin America.

Science is in the process of shifting from the avocation of part-time amateurs to the full-time task of professionals. The transition requires extensive institutional adjustments, changes in attitudes and in the location of authority, and a great deal of money. Hence the process of shifting to the establishment of professional scientists as a reorganized class -- numerous, respected, well rewarded, well equipped and housed, and established in stable instituions -- can be expected to continue over a long period.

The establishment of reasonable salaries for full-time investigators is critically important. In many countries, full-time salaries are so low as to discourage talented people from pursuing research careers. For example, in Colombia the starting salary at the National University is $333 per month. In Peru, the maximum full-time academic salary is $550 per month, equivalent to half the maximum salary of public service employees. In contract, full-time research salaries range from $700 to $1,600 per month in Venezuela, with an income tax of 8 per cent. Those who do so must often have two or more jobs, and this in effect makes them part-time and decrease their effectiveness. Some must have independent sources of income and this introduces selection factor other than merit. Of all simple, feasible (because numbers are small) and highly effective actions that governments might take, establishment of adequate full-time salaries for full-time scientists has the highest priority.

(h) The sporadic and discontinuous character of research in many universities has been a handicap. This discontinuity is traceable in large part to the dominance of individuals; to the absence of a system, which perpertuates an outdated research tradition; and to lack of intellectual pre-eminence. Sometimes younger leaders have not been trained to take over, and institutes and departments have therefore become intellectually moribund. The prestige of a universtiy degree and the development of a middle class have combined to generate this tremendous rise in enrollment in most Latin American universities.[1/] Since it is impossible to meet adequately the needs of large student bodies with professional staff and facilities adequate only for normal-size classes, research obviously suffers. The use by teachers of part of their time for research has been strongly criticized by students in some universities, who called it unnecessary "scientificism." There have been instances in which students have prevented the acceptance by their universities of donations for research, especially if the funds came from foreign sources.

(j) The system under which the government of universities is shared by faculty, students, and alumni is found in many universities. This system has deep and complex roots and also important effects upon virtually all universities so governed. Generally, though not always, the system of co-government acts to restrict the development of research because of widespread emphasis on the need to improve the quality of teaching and the capacity to teach more students, combined with erroneous notions that any research detracts from, rather than enriches, teaching. The foreign origin of much financial support for research has also generated opposition to research in some universities with a system of co-government.

1/ An incident in Argentina in January 1973, as reported in the New York Times of Feb. 2, 1973 is instructive. The faculty of the Medical School of the University of Buenos Aires undertook to elevate the qulification of those admitted from a group of 2,200 applicants. Those turned down mounted a political campaign to be admitted, and the Rector of the University defended their cause. He was dismissed b y the government. The outcome remains in doubt, but limitation on enrollment to those with minimum qualifications seems dobtful. A generally similar situation exists in the Medical School of the National University of Mexico (where an effort is being made to reduce the entering class to 5,000) and in many Brazilian schools of medicine

4.6 Health Research Outside Universities

Much important health research is conducted outside universities, for a number of reasons. When universities are, for any number of reasons, incapable of serving as the home of productive research, pressures are generated to set up organizations outside universities to avoid the handicaps then existing in universities. These organizations are typically organized, staffed, and financed independently of universities.[1/] They may in form be free standing institutes or foundations, organizations within ministries of health, elements of social security organizations, or parts of hospitals not associated with ministries of health or social security systems. Their staffs -- senior and junior -- move freely among the key laboratories of the world, and collaborators from these laboratories are always found at work in the pre-emeinent institutes.

Many institutes have flourished and continued to grow in quality, in breadth, or in both. Institutes face the problem of self-renewal and of transcending their dependence on individuals. Many have solved the problem, often by agreements with universities to provide postgraduate training

Achievement of this goal depends on sustained, wise leadership.

It is difficult to identify these institutes by name because, on the one hand, a complete catalogue is impossible and, on the other, an illustrative listing will omit some institutes comparable in excellence to those mentioned. Nevertheless, specificity is necessary to make concrete, for those who do not know the situation well, the identity of some of these strong points. The National

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1/ Often health research within universities is organized in an "institute." These inter-university institutes are established for various reasons -- to provide visibility for the function and the Director, to attract funds, or to escape the limitations imposed when there can be only one professor in a field. However, in this section only institutes outside universities are discussed.

Institutes of Nutrition and of Cardiology and the National Institute of Scientific Research of the Children's Hospital in Mexico come to mind. In Buenos Aires, the Campomar Foundation is famous throughout the world; IVIC in Venezuela has a similar reputation.

Maintenance and strengthening of the assets represented by such outstanding institutes should be a central element of national research policy.

At the same time, the fact that a research organization is called an "institute" is not a guarantee of excellence. In fact, institutes differ so widely that the word really does not describe a single homogeneous class of institutions. A few institutes are privately financed; most are publicly financed. Some are large, and some are small. Like all institutions, they can grow or diminish in strength over a period of time. There are examples of very strong institutes whose productivity has declined. Often this is traceable to the loss of an outstanding leader or to a shift in aspects of scientific growth without a corresponding shift in the institute's approach. Often the resurgence of universities and the development of relatively unfavorable salary scales in institutes can cause them to decline in quality. This has in fact happend recently in Brazil where the major independent institutes have lost momentum, and little research of high quality is being produced.

While there is no general formula that will answer the extremely complex issues involved in the relative decline of institutes, these approaches can be suggested:

(a) Roestablishment of effective scientific leadership, which must often in the real world await the departure of a director through dismissal, retirement, or death;

(b) Establishment of comparable pay scales, particularly if university salaries have in the past increased more rapidly than institute salaries. (Historically, one of the forces leading to the establishment of institutes has been low university

salaries. However, over time university salaries have sometimes (as in Brazil) improved while those in institutes have not.) A reasonable general formula is to establish beginning salaries which equate the salaries of instructors in universities with those of junior investigators in institutes. Once this "floor" has been established, promotion and salary increases should depend on performance.

(c) Establishment of career opportunities in institutes.

Generally, the resolution of difficulties faced by declining institutes is possible only through some kind of outside intervention by a Ministry, a National Academy of Science or a National Research Council. This is usually the case because there must be some group, whose legitimacy, objectivity, and prestige are / widely accepted, to decide such matters as proper salary scales, who shall be promoted, who shall be the new director, and so forth.

It must be emphasized that there is no inherent advantage to either the university or the institute form of organization for research. Those who claim inherent superiority of the university generally implicitly assume an ideally functioning university and a poorly functioning institute. Those who claim inherent superiority for the institute make the opposite assumption.

Therefore, the question is not whether the autonomous institute or the university is the "better" form of organization. There is no theoretical and no practical answer to this question. At one time in a specific set of circumstances, it may be wise to set up research structures outside universities / ; in other circumstances this would be a mistake.

The indicated course of action is to define goals, to determine the essentials required to achieve these goals, and then to use, modify, or create the institutions best adapted to the purpose. In this perspective, it is clear that the best institutes should be cherished and strengthened. At the same time, the individuals and private organizations concerned, and the governments, face the practical problem of restoring vigor to institutes that have become less effective over the years. (One problem that no country has been able to solve

satisfactorily is how to shut down a research institute whose function has disappeared or whose condition is so poor that it cannot be restored to vigorous intellectual life.

Similarly with universities: the preceding section has noted both the indispensability of this tried and tested institution over the long run and also the extremely difficult practical problems in lifting many universities from the realities of their present capacility and outlook to the ideal model of the university in the modern world.

If any generalizations are possible in this complex of problems, it is probably that both institutes and universities are required and that both of them must, in different ways, participate actively in research and in teaching.

5. Organization of Health Research at the National Level

5.1. Introduction

While research is conducted by individuals and groups that are situated physically and administratively in university faculties or in institutes, their work is influenced by a superstructure of national groups of various kinds. This superstructure typically deals with more general problems than those dealt with by scientists as scientists or by the institutions in which they work. The establishment of a productive national structure for biomedical research, or for all research, is a difficult matter. No nation has evolved a system with which it feels fully comfortable. A sense of experimentation arises from the fact that only recently has the significance of the interrelationships between science and national policy been recognized. A sense of uneasiness arises from the fact that national science policy is the interface between science and politics.

The meaning of national policy is elusive in any field, and the meaning of national policy for research is no exception. A useful definition of national science policy is "the totality of actions deliberately taken by national governments with respect to research." These actions include the decisions arrived at as a consequence of the interaction of individual ideas, organizational interests, the limitations imposed by shortage of resources, the compromises necessary when scarce resources must be allocated, and the general cultural and political forces that bear on decisions. It is worth noting that/this in sense, as has been said above, every nation has a science policy consisting of de facto decisions. If the decisions are to be sound and the government's choices intelligent, deliberate attention must be paid to these matters at the national level. Attention can be centered on them adequately only if there is some machinery available for collecting the information prerequisite to rational examination of the issues and if some governmental device or devices exist for exposing the choices to be made.

Health research is generally organized on a national besis in Latin America through several devices -- Ministries of Health, National Research Councils, national academies of science and professional societies and social security systems. All

nations have ministries of health. All nations with significant health research now have national research councils. Relatively few countries have national academies of science or social security systems with a significant health research component. There is no typical pattern of administration, and no pattern which seems demonstrably superior.

Each of these types of organization serves different functions. National research councils are governmental bodies which perform either one or two functions -- establishment of science policy and distribution of funds for research. Ministries of health administer governmental health programs and in the course of carrying out this responsibility, they often carry on health research in such fields as vaccine testing and production, hospital administration and epidemiology. National academies of science are typically private, honorific groups which usually do not support research. Social security system often administer health insurance programs which are supported by payroll taxes. In a few countries, these systems serve as the base for limited health research programs.

5.2. National research councils and other bodies

One of the most striking developments in science in Latin America in recent years has been the establishment of national research councils.[1/] In 1967, only Argentina and Brazil had operational national research councils. In the following six years such councils were established in Colombia, Costa Rica, Chile, Jamaica, Mexico, Peru, Trinidad and Tobago, Uruguay Venezuela. Costa Rica is in the process of

In addition, the wealthy and effective Research Council of the State of Sao Paulo (FAPESP) must be mentioned as a unique regional council. The health sciences are in all cases encompassed within the activities of these Councils.

1/ The Organization of American States and the Development of Science: Final report of the OAS Advisory Committee on Science Development, Pan American Union Washington, D.C., 1959, pp. 20 and 38. Organization for Economic Cooperation and Development, Science and the Policies of Governments: The Implications of Science and Technology for National and International Affairs, Paris, 1963. 37-45. La Politica Cientifica en America Latina. UMESCO Publicacion No. 29, Paris, 1971

The remarkable rate at which these councils have been set up in recent years is the consequence of a number of forces. The importance of science to the development of Latin America was dramatically recognized for the first time at the highest political level in the Declaration of the President of the Americas, signed in Punta del Este, Uruguay, in 1967. This recognition was important. The Organization of American States and UNESCO have worked through various mechanisms to encourage the establishment of National Research Councils. This high level guidance had an important influence within individual countries.

In addition to the impetus provided by the OAS, there has been a world-wide trend towards recognition of the significance of science and technology to the economic, social and cultural development of nations and towards the establishment of central govermental bodies charged with fostering science and technology and with the integration of science and technology with broader plans for national development. Latin American countries have been influenced by these trends, partly through the influence of international organizations such as UNESCO, OAS and the U.N./ECOSOC Advisory Committee Commission on Science and Technology (check title) and partly through the simple diffusion of ideas.

The various councils have many functions stated in their charters, and their charters are remarkably similar:1/

- Popularization of science among the public
- Strengthening science education
- Support of science through provision of research grants.
- Repatriation of scientists
- Support of students through provision of fellowships.
- Establishment of National research priorities, and of plans for science
- Efforts to make science a more effective device for economic and social development

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1/ Charters of some of the Councils are in the following documents:

Argentina
Reglamento Interno del Concejo Nacional de Investigaciones Cientificas y Tecnicas. Aprobado por Decreto he 6.035, 25 de abril de 1958.

Chilia
Organic Statute of the National Commission for Scientific and Technological Research, Santiago, January 27, 1969.

Colombia
National Council for Science and Technology and the Colombian Fund for Scientific Research and Special Projects, "Francisco Jose de Caldas". Decree No. 2869. November 20, 1968.

Mexico
Tey Que Crea el Consejo Nacional de Ciencia y Tecnologia, México, D.F. December 27, 1970.

Peru
National Research Council. Decree - Law No. 17086, Lima, November 6, 1968.

Venezuela
Tey del Consejo Nacional de Investigaciones Cientificas y Tecnologicas. 26 Junio, 1967.

- Development of better information and documentation services.
- Coordination of the efforts and resources devoted to science in the country
- Establishment of science as a component of overall National development plans.

This is an ambitious list. Few Councils in fact perform the full range of functions, and limitations on resources usually restrict the capability of the Councils to perform effectively even those limited functions which they undertake 1/

The effectiveness of the Councils varies widely. Over the years, the National Council for Scientific and Technical Research (CONICYT) founded in 1958 in Argentina has been a strong force in the development of science, including the biomedical area, in substantial part as a consequence of the influence of Don Bernardo Houssay. However, in recent years, the funds available for research have declined in real terms despite the establishment in 1968 of the National Council for Science and Technology (CONICYT) at the highest levels of government. The budget of the National Council for Scientific and Technical Research (CONICYT) has remained constant in money terms, and declined markedly in real terms because of inflation, over the past five years. Over this period, funds available for the physical sciences have increased from 27 to 45 percent of the budget while funds for medical sciences have declined from 22 to 14 percent of the budget.

1/ Data on the financing of research and development, and on the finances of national research councils and similar groups are improving but information in many countries is scarce or nonexistent. This accounts for the differences in the detail of data in the following paragraphs.

The Brazilian National Research Council (CNPq) and the regional Sao Paulo Research Foundation FAPESP are powerful, comprehensive and well financed organizations. Their capability has expanded markedly over the past five years. There are in addition to these two groups other powerful national scientific organizations in Brazil which in total are better financed than the research councils. For example, the National Fund for Scientific and Technical Development (FUNDCT) an arm of the Ministry of Planning and Coordination established in 1969 had an annual budget of 30.5 million dollars in 1973. The Fund for Scientific and Technical Development of the Economic Development Bank FUNTEC although smaller also distributes more money than the National Research Council. Finally, CAPES (Coordinación del Perfeccionamiento del Personal de Ensenanza Superior) within the Ministry of Education provides large numbers of fellowships for students in science.

These organizations are well financed and their funds are increasing rapidly even when inflation is taken into account, as is indicated in the following tables. The proliferation of agencies for support of research in Brazil reflects a strong national commitment to research, a strong economy, and a belief that a traditional research council alone is not adequate to exploit all research and technological approaches to national problems.

Table 1

Budgets of Four Brazilian Agencies Important in the Promotion of Research

(In millions of Cruzeiros)

	1965 1/	1971 1/	Factor of increase	Equivalent of the 1971 budget in millions of US dollars 2/
National Research Council (C N Pq) 3/	30.0	65.5	2.18	12.2
Coordinating Agency for Advanced Training (CAPES) 4/	22.6	25.5	1.13	4.8
Research Fund of the Bank for Development (FUNTEC/BNDE) 5/	3.8	106.5	28.00	19.8
S. Paulo Foundation for the Promotion of Research (FAPESP) 6/	9.1	27.6	3.04	5.1

1/ Adjusted to a constant value cruzeiro for 1971. Indexes for Wholesale Prices (Products for Domestic Use, All Commodities) as follows: 1965: 71.6; 1971: 271.0. These are the "official" indexes and were taken from Conjunctura Economica (Fundação Getulio Vargas), Vol. 26, pag. 117, September 1972.

2/ At the exchange rate of 5.37 Cruzeiros per 1.0 US$

Table 1 (Continuation)

3/ Source : For 1965: Science Policy in Latin America. PAHO. Scientific Publication No. 119, 1966, page 65
For 1971 : Ferreira, Jose Pelucio, in Politica Cientifica, Editora Perspectiva, Sao Paulo, 1972, page 247

4/ Source : For 1965: Science Policy in Latin America, PAHO, Scientific Publication No. 119, 1966, page 63.
For 1971: CAPES, Relatorio de 1971, page 22

5/ Source : For 1965: Dr. Silvando Cardoso, BNDE, personal communication
For 1971 : BNDE, Relatorio de 1971 page 46

6/ Source : For 1965 and 1971: FAPESP, Relatorio de 1971, page 17

Table 2

Trends in Support of Biomedical Research by Three Brazilian granting Agencies (Millions of Cruzeiros 1972)

National Research Council, CNPq

	1965	1970
Grants and Fellowships for Biomedicine	1.20	6.97
Total Budget	7.87	50.45
% of Grants and Felloships for Biomedicine	15.3	13.8

Coordinating Agency for Advanced Training, CAPES

	1965	1971
Fellowships and Aids to Centers, for Biomedicine	1.80	6.93
Total Fellowships and Aids to Centers	4.86	22.51
% of Fellowships and Aids to Centers, for Biomedicine	37.1	30.6

S. Paulo Foundation for the Promotion of Research, FAPESP

	1963	1971
Grants and Fellowships for Biomedicine	0.13	6.8
Total Grants and Fellowships	0.48	21.2
% Grants and Fellowships for Biomedicine	27.0	32.0

Sources: Same as those for Table 3 and CNPq Relatorio, 1970.

Table 3

Preliminary Budget for Science and Technology
Federal Funds
1972-1974
(Millions of Cruzeiros, 1972)*

	1972	1973	1974
Special Governmental Enterprises and Autonomous Agencies	267.4	234.3	255.3
National Research Council, CNPq	57.6	59.6	62.3
Coordinating Agency for Advanced Training, CAPES	28.0	30.5	32.2
National Fund for Scientific and Technological Development a) (FNDCT) of the Ministry of Planning	133.9	180.0	194.1
Research Fund of the Bank for Development, FUNTEC b)	102.9	100.0	100.0
Total	649.8	670.4	717.9

a) Includes funds to be transferred to CNPq

b) This fund, to be administered originally by the Bank of Development, has been transferred to FNDCT.

* Source : Ferreira, J.P., in Politica Cientifica, Editora Perspectiva Sao Paulo, 1972, page 248.

In Venezuela, the total National investment in research in 1972 was 202 million Bolivars, or $40.6 million, and all but 3 percent of this is from public sources.[1/] This is double the level of 1965. /The budget of the Venezuelan National Council for Science and Technology (CONICYT) has grown from about 1 million Bolivars in 1965 to about 20 million Bolivars (about $4 million) in 1972. Therefore about 10 percent of the total National investment is through CONICYT. The remaining amounts are accounted for primarily by governmental support of universities and research institutes.

Of the total National research investment, 15 percent is for the medical sciences and an additional 13 percent is for the biological sciences. To provide a basis for comparison, 19 percent of the National research investment is for agriculture and 12 percent is for engineering and economics.

In terms of personnel, 32 percent (the largest group) of the total of 2,500 qualified scientists are in the medical sciences and an additional 16 percent are in the biological sciences.

About 35 percent of the research in Venezuela is basic, 60 percent applied and 5 percent is for development. The comparative figures in England are 10, 20 and 70; in France, 20, 40 and 40; in the United States 15, 25, and 60.[2/] These figures, despite obvious problems of definition and comparability, indicate the general tendency of Latin American countries to invest relatively more in basic research and relatively less in development than is the case in Western Europe and the United States.

About .23 percent of the GMP in Venezuela is devoted to research and development.

1/ Data for Venezuela drawn primarily from Peñalver, LM., La Ciencia y la Technología en Venezuela in Ciencia Interamericana, September-December. 1972, Vol 13 Nos 5 and 6, p. 2, OAS, Washington, D.C. Of all Latin American countries, Venezuela has the most extensive and best organized system for measuring and assessing its scientific and technological resources.

2/ National Patterns of R&D Resources, Funds and Manpower in the United States, 1953-1972. National Science Foundation, Washington, D.C.

Colombia has developed separate organizations to carry out policy and funding functions. The National Council for Science and Technology (CONCYT) works on the development of general plan for the development of science and technology and their integration with general national development plans. The Colombian Fund for Scientific Research (Colciencias) concentrates on more specific matters, such as developint an inventory of scientific resources, developing science and technology in the public and private sector, development of scientific institutions (including graduate education) and promotion of special programs (meteorology and quality control, for example). The expenditures of the organization in 1971 were as follows:

(in millions of pesos)

Director and administration	5.0	
Studies and planning	3.2	
Research promotion (90% grants)	8.1	
Institutional promotion	1.9	
Special programs*	5.8	
Total	24.0	($1.3 millions)

As in Brazil, although on a much smaller scale, there are sources of support for research in Colombia that rival in importance the National funds for scientific research. For example, in Cali, Universidad del Valle has a Research Fund that receives a small support from COLCIENCIAS (50,000 pesos) and the Colombian Foundation for Higher Education (150,000 pesos), a non-profit private enterprise, involving the leaders of the private sector that receives in deposit all private grants given initially to Universidad del Valle and now including 50 institutions and pays them 1.5% interest/months, keeping the funds in a checking account. The Foundation also handles salary payments

*Problem solving oriented: information, food technology, quality control, etc.

for the institutions and solicits donations for higher education. The Foundation "earned" 0.5 million of pesos in 1966 and went up to 9.5 millions in 1971 and an estimated 12 millions in 1972. Donations increased up to 5.4 millions in 1970, decreasing to 3 millions in 1971 when universities were closed. They are granting 15 million pesos per year to the 50 member institutions ($833.333).

Mexico has a new National Council for Science and Technology which is stronger than any prior organization in the nation, but still less fully developed and funded than those in Argentina, Brazil and Venezuela. Only .13 percent of the GMP of Mexico is devoted to research and development.

The Chilean National Research Council provides a central scientific policy group, but it is handicapped by severe underfunding and by the priority of political over scientific qualifications for members of the Council itself and its staff.

The research council in Peru and Uruguay have never had sufficient funds to exercise substantial influence over science and technology in their respective countries.

The establishment of National scientific bodies, a purpose now largely achieved, has for many years been a major goal among those interested. No other group were considered adequate to perform National science policy functions. For example, traditional academies of science are not best equipped to perform this function because they tend to view science solely in its own terms and not in terms of the social, political, economic, and administrative complex within which it operates or in terms of its social functions. Professional societies are too specialized. Ministries are primarily concerned with their operating functions, and they are subordinate parts of government.

National Councils

It was thought that these / could provide a setting in which science could be considered as part of society, in which the roles of various institutions in science could be examined, in which thought could be given to means by which science can best be developed as science and as an instrument for elevating levels of human welfare, in which the resources available for and necessary for science could be estimated, in which the relationships between science and education could be assessed, in which the desirability and characteristics of common national measures for science could be discussed, and in which some elements of programs for the development of science could be administered. It was thought that one important role for a national research body would be to serve as an effective link between individual scientists, their societies, and the universities and institutes on the one hand and international organizations on the other. The facilities, resources, and influence potentially available to the scientific efforts of individual countries could be provided most easily and most effectively if the international organizations have some group to which they can turn in each country. Conversely, the needs of each country could be expressed most coherently and effectively through a national body. Not all these functions need be performed by research councils, and others not listed may be performed, but this brief inventory indicates the general nature of the tasks that were thought of as the central tasks for councils.

Now that research councils have actually been established in all countries with large health research programs, a preliminary assessment of their value and of the conditions for success is possible. On the one hand, as has been pointed out, they have been positive forces in all countries and very powerful in a few countries. On the other hand they have not yet fulfilled adequately the functions mentioned in the preceding paragraph.

Problems have arisen in a number of countries. Some research councils have spent too much money on administration, and too little on research. Inadequate funding handicaps many councils. The link between science and general national planning which is excellent in theory sometimes leads to involvement in futile planning exercises to the detriment of more direct research and development functions. In some countries, there are not enough scientists to provide the necessary competent and impartial advice. Establishment of a central science planning organization involves science in political activity, and tends to make science share the instability of politics. Central scientific organizations sometimes tend to ignore strong existing scientific institutions, and to centralize decisions without securing adequate participation. Sometimes central science organizations tend to be removed from real problems of development, and to plan in abstract and unproductive ways.

When science, including the health sciences, are closely linked to central planning bodies or other central political organizations, there is a strong tendency to emphasize applied science. The Councils are sometimes the major agents through which pressure is applied. This sometimes generates tension between the scientific community and research councils. In view of the tendency to pursue basic science not derived from nor applicable to the solution of important current problems, this social pressure on science may be useful. However, if the pressure is applied crudely and without intelligence and discrimination, harm can be done without generating good and useful science. There is a worldwide reexamination of the role of science in society and the pressures that are seen in Latin America are part of a change that is occurring in virtually all countries.

Many of these problems were foreseen by scientists, and there is now in some countries a fairly widespread feeling that somewhat less centralization would be desirable as a means of coping with the problems noted above.

One fairly general proposal is to separate the central policy and planning function from the function of providing funds for science. This is the pattern in Argentina and Colombia, for example. Another proposal is to establish sectoral groups such as the physical sciences, engineering and the health sciences. This disaggregation is held to be a means of generating better contact with problems decreasing political influence over science, increasing the technical competence of staffs, and securing wider participation of the scientific community in making decisions.

In summary, a marked tendency of the past five years has been to establish National research councils with common functions. They have been useful in generating funds and in planning science. The resources and the total effectiveness of the Councils vary widely from country to country. However, serious and complicated difficulties have arisen in the operation of many Councils, and there is now less optimism than there was in earlier years that these bodies in themselves will solve the problems of the development of science in all countries.

5.3 Ministerial activity

In most Latin American countries, the university systems are linked to the government through the ministries of education. The relationships vary, in different countries and at different times, from active ministry support of universities through neutrality to the imposition of bureaucratic red tape and political interference. All in all, there is a need for sustained, far-seeing, stable statesmanship on the part of ministries of education that will be helpful in university development.

The ministries of health are more significant for biomedical research than are the ministries of education. The ministries of health of the various countries differ in the degree of their involvement in research. A number of ministries of health produce or monitor the production of vacines, and they conduct research related to these activities. The majority participate through research institutes

and schools of public health, and through support of specified field-research programs in faculties of medicine. In these cases, however, there is obviously opportunity for significant development. Ministries might make greater contact with schools of public health (where these are separate from the ministries) and with the departments of preventive medicine in faculties of medicine. Their combined efforts and the facilities available (e.g., local health units, laboratories, hospitals, and record systems) would make practicable much greater study of local communities, which in most of Latin America are undergoing rapid change. Studies of morbidity and mortality rates, record systems, the epidemiology of diseases, demographic changes, states of nutrition, and health education and disease control programs are examples of the kinds of joint activity that would contribute significantly to student training and to communal knowledge. Undoubtedly, this kind of data collection would in itself generate as many questions as answers. In this connection, it is important to recognize the need for marked development of the social sciences in Latin America and to recognize their potential contribution to public health research.

One aspect of public health research that needs sponsorship at the ministerial level is administrative research. This entails studies of costs for particular services, travel distances, and so on, and when effectively performed yields invaluable information relating to the economic and efficient use of limited funds. Such information can be made applicable to a variety of planned or proposed services and differs from public health program evaluation.

As a general rule, most biomedical research is not conducted in establishments responsible to the ministries of health. The institutes are generally autonomous, as are univerity faculties, even though they are generally state-financed and even though the universities are often placed administratively in ministries of education. This arrangement is commonly considered preferable to placing all biomedical research under the control of the ministry of health.

5.4 Scientific academies and societies

Scientists in virtually all the Latin American countries have recognized the importance of private professional associations. The professional society plays a unique role by providing the individual scientist and those who speak for working scientists with a means of communicating more effectively with their fellows and for expressing the views and advancing the interests of their specialties. Although in practically all Latin American countries there are societies that deal with biomedical problems, their scope is usually local, and some of them, furthermore, are more interested in the "practical" problems of professional practice than in scientific matters. Five major organizations group together societies of the different countries -- the Latin American Society for the Physiological Sciences (1956), with headquarters in Uruguay, the Latin American Microbiological Congress (1958); and the Pan American Association of Biochemical Societies (1970), the Pan American Congress of Endocrinology; and the Latin American Society of Nuclear Biology and Medicine.

Academies of medicine and similar societies usually limit their activities to the organization of scientific meetings, the publishing of journals and memoirs, and frequently the dispensing of scientific awards. There are, however, exceptions. The Argentine National Academy of Medicine, supports two special research centers -- the Institute of Cardiology and the Institute of Hematology. The prestigious Mexican Academy of Medicine provides significant advice to the government and administers a modest program of research support.

These academies and scientific societies, many of which have prestige and distinguished leadership, should constitute centers of stimulus, clearinghouses for ideas, and foci of professional goals, not only for their members but for other scientists as well.

There is a need for more societies that would encompass the activities of

several countries and for better planning of the publishing activities -- on a regional or continental basis. There is also a need for rejuvenation of some of the societies.

Assistance to make possible the holding of Latin American congresses and meetings should be encouraged. Usually Latin American scientists do not know each other, and if they do become acquainted their introduction very often takes place in the United States or in Europe.

5.5. Social Security Systems.

The government health insurance systems provide a largely untapped resource for health research in Latin America. Most of the resources required for research, and particularly for clinical research and studies of population groups, are in place in these organizations. They have medical staffs, hospitals and clinics, clinical records and clinical laboratories. Moreover, they face both medical and administrative problems which can be solved by research. The same is true of large public hospitals which may be operated by trade unions, for government employees, or for members of armed forced. The obstacles to wider use of these organizations and their resources for research are generally twofold -- money and leadership. Expenditure of relatively modest funds, comined with a firm policy and competent scientific leadership could add a substantial increment to the health research of many countries.

The Mexican Institute of Social Security (Instituto Mexicano del Seguro Social, IMSS) is a particularly impressive example of health research associated with a social security system. The most important development in Mexico in the past five years is the growth of the IMSS. IMSS has emerged as the major organization for programs of health care delivery (involving 10,000 physicians and about 10,000,000 patients), clinical training, preventive medicine, family planning and basic and applied research. IMSS has attracted quality people in its administrative and

operational structure and has provided attractive salaries, facilities and environment for practice of quality medicine and quality research. The commitment of IMSS to research is impressive with an annual budget in 1973 of over $2,000,000. IMSS has a committed policy of fostering basic and applied research as an essential part of medical training and practice. Its present and predicted rate of growth make it clear that IMSS will be the major organization dealing with health care delivery and biomedical research in the near future.

IMSS is extending its operation outside of México City with new facilities being developed in Guadalajara, Monterrey and Vera Cruz.

In summary, the rapidly growing IMSS is a major factor in effective health care delivery, improvement of standards of medical care and of basic and applied research in Mexico. The large financial resources, the involvement of one-third of all the M.D.'s in Mexico, the realistic salaries paid, the high quality of key administrative staff and the serious commitment to support of quality research are all important factors contributing to the dynamic quality of health research in Mexico.

As another example, Chile's National Health Service has a tradition of excellence extending over many decades. The great majority of Chilean physicians are involved with the system which provides health services and facilities for about 80 percent of the population. The Service has been noted for the quality of its research relating to the delivery of medical care. It also sponsors biomedical research and works in a close relationship with the university.

6. External Support -- Nation to Nation

6.1. Introduction

Over the past five years there has been a marked decrease in support for health research in Latin America by governments and foundations outside Latin America, and an increase in support by international agencies. At the same time, internal support has increased in many Latin American Countries and the internal structures for planning and financing research have been strengthened, as noted in the preceding chapter. This trend is basically healthy. Reliance on foreign Governments - for the most part in this case the United States - has tended to shift the power to determine national priorities from the countries directly concerned, and to establish an undersirable degree of dependence/to shift attention of Latin American countries from their basic obligation to support research. Finally the bilateral arrangements have tended to divert attention from the need for collaborative efforts among Latin American countries. On the other hand, external support provided by international agencies brings many ancillary benefits. Latin American countries jointly participate in decisions relating to support -- how much will be available in total, how the total amount should be divided by objective and by country, and the terms and conditions under which funds should be made available. External support of research has been accompanied by expansion of scientific training of the highest quality in excellent laboratories. In addition, international support tends to foster collaborative efforts.

In spite of the undeniable significance of various kinds of international involvement in the development of all sciences in Latin America, it is well to bear constantly in mind that the foundation for productive development over the long run is within each nation. The whole effort in each nation continues to depend on the wisdom and foresight with which domestic affairs are handled. With sound domestic policies, international efforts can add a great deal. Without sound domestic policies, international activities tend to be episodic and ephemeral.

Nevertheless, the shift of support from one source to another always causes difficulty, and the decline of funds from the United States government and

private foundation has generated severe difficulties for many investigators and laboratories.

6.2. Decline in Support from Governments and Foundations Outside Latin America

6.2.1. Foundations

There is a widespread feeling of gratitude in Latin America for the pioneering work of the Rockefeller Foundation and for the help of other foundations. The Rockefeller Foundation supported an extensive campaign agains yellow fever, hook-worm disease and malaria. Many of the persons trained in these campaigns later became leaders in medical education and medical research. The Foundation later offered numerous predoctoral and postdoctoral fellowships for study in the United States and became involved in the development of science departments and in supporting the research activities of exceptional individuals. It began its work at existing local levels and then attempted to contribute to continuing improvement. The programs ranged from the most applied to the most fundamental research, with consistent emphasis on training so that there would be a constantly increasing number of persons contributing to progress in these fields. A large proportion of the Latin American leaders in biomedical science were recipients of fellowships or other support from the Rockefeller Foundation. Because of the flexibility of private foundations and their ability to earmark funds for long term programs, the Rockefeller Foundation was able to offer stable support that is particularly important in the development of a department or institution or in highly experimental scientific projects. Through their use of "matching funds," they have done much to increase the involvement of Latin American institutions in supporting their own programs and scientists. Between 1955 and 1963 the Rockefeller Foundation provided $20 million to 12 Latin American countries for health research and training.

As a result of a policy decision made in 1963, the Rockefeller Foundation has withdrawn from its traditional support of the biomedical fields, concentrating

its efforts abroad on the conquest of hunger, population dynamics, and strengthening the developing centers of learning in the newly emerging nations, primarily in Africa.

The Foundation is continuing its support in Latin America for the development of a limited number of training centers in the biomedical sciences, particularly the University of the Valley in Cali, Colombia, and the Medical School of Ribeirao Preto in Brazil. The medical school at Cali has trained large number of basic and clinical medical scientists from at least 13 other Latin American countries.

The change in the policy of the Rockefeller Foundation has been counteracted somewhat, but not altogether by the activities of other private foundations. The Milbank Memorial Fund has stressed medical education and studies of national resources -- particularly manpower. The Kellogg Foundation has been an important factor in stimulating research and training especially in public health. The Ford Foundation has invested substantial sums in university development, and particularly in the development of new patterns of graduate education in the sciences. Although the combined efforts of these foundations have not been directed specifically toward biomedical research, they have played an important role in developing the people and the institutions that are indispensable to a sound medical research effort.

In summary, the era of major influence by United States foundations on biomedical research has ended. A major influence, and a very positive influence, has disappeared. The continuing help of foundations is productive and gladly accepted, but it is no longer a central force on a continental scale.

6.2.2. Governments

A number of governments outside Latin America have provided substantial assistance to biomedical research in the area. However, it has not been possible to measure the nature and volume of this assistance except that part of it coming from the United States. Most of the aid from Europe is in the form of exchange of students and professors and in opportunities to use European research facilities. France, Great Britain, Germany and Sweden are among the countries making most of these cooperative opportunities available.

One of the important enduring indirect effects of World War II on Latin America has been to reorient the health research from Europe to the United States. Before World War II, study and work in European laboratories and universities was the goal for most of the able advanced students in Latin America. During the war transportation between Latin America and Europe was disrupted, and only the United States was available for those who desired advanced work outside Latin America. During these years and later, science in the United States underwent a tremendous quantitative and qualitative expansion. The flow of students and professors to the United States continued and expanded after the war; the result was the establishment of a closely woven set of personal and professional relationships in all fields of science, including the health sciences.

Since the health sciences have developed most extensively in Latin America, these relationships have been most extensive in this field. They have been a fundamental fact in the external influences on biomedical research in Latin America over the past 20 years.

Various branches of the United States Government have provided a number of forms of assistance to biomedical research in Latin America. The annual volume of support in the form of research grants and contracts reached a peak of 3.5 million dollars a year in 1963, distributed roughly as follows:

Agency	Amount (in millions of dollars)
National Institutes of Health.....	2.8
Department of Defense.....	.5
Other.....	.4
Total.....	3.7

Over the decade 1963-1972, the medical research grants from the United States National Institutes of Health totalled $18 million. Of this $12 million was in the form of support to individuals, and $6 million was provided to PAHO. Most of the outstanding investigators in the region received support during part of this period. However, the peak of support was reached in 1963 and the funds available declined rapidly beginning in 1966. Moreover, the grants to individual

investigators have decreased from about 100 grants amounting to about $2 million in 1965 to 11 grants amounting to $229,000 in 1972. On the other hand, grants to PAHO have remained relatively constant and have increased in recent years.

The United States Army continues relatively small support for studies of Venezuelan Equine Encephalitis, leishmaniasis, malaria, plague and schistosomiasis.

6.3. Effects of the Decline in External Support

With the virtual cessation of NIH and other U.S. government support, some observations on the era of heavy investment by the United States in Latin America are in order. First, there is no doubt that the total pattern of relationships between the United States and Latin American countries in the health science has been productive in many respects and on balance for both parties. In terms of science, the funds have provided a strong stimulus to productive investigators. In terms of advanced learning, those who have studied in universities and hospitals in the United States now form a substantial proportion of the leaders in biomedical research. This training has provided not only technical competence but also new views on the organization of universities and graduate education. Finally, learning is becoming to an increasing degree a two-way process, as more scientists from the United States establish collaborative relationships with colleagues in Latin America laboratories. For these reasons, the decline in support represents a loss and a set back.

However, in retrospect the heavy dependence upon support from governments and foundations outside Latin America had important adverse consequences:

(a) Imposition of inappropriate models

Students who study in the United States and Europe often learn not only skills but values which are not appropriate in their home countries. This is a problem to be dealt with irrespective of the source of funds for study abroad. One important means of coping with this problem is to send students abroad for

study only after training opportunities in the region have been exhausted, and only when there is reasonable assurance of a stable career when they return.

The tendency to look abroad for guidance in such matters as institutional governance and administration, research planning, patterns of graduate education has been fostered by financial dependence on foreign funds.

Latin American countries can increasingly use native models of development of biomedical research rather than to seek solutions in the United States or Europe. In Latin America there are models of such important matters as excellent university development, sophisticated research planning, first-class postgraduate education, good administration of research institutes, national agencies for scientific promotion and policy with valuable experience, examples of successful international regional cooperation, and promising efforts at combining the basic and applied research. This is not to advocate the isolation of the region or to suggest that everything done there deserves to be emulated. On the other hand, Latin Americans clearly have much of value to learn from one another. The intelligent thing to do would be to pay more attention to successful regional models and to carefully analyze failures and local difficulties.

(b) Inappropriate transfer of responsibility

When too high a proportion of funds for biomedical research are received from sources outside a given country, there can be a tendency of the government to ignore its responsibility to finance biomedical research. This was the case in some countries in Latin America when outside assistance was at a high level.

Over the long run, the health of science -- including biomedical science -- in a country depends upon support by the nation and not upon outside support. It is unhealthy to have any major area of national concern dependent upon outside sources.

(c) Establishment of inappropriate research priorities.

At this point a fundamental characteristic of the financing of universities in Latin America must be stressed.

The typical pattern of financing health research in Latin America has made

it possible for a small amount of external funds to exercise a decisive effect upon the direction of research. The important fact to hear in mind is that local sources (typically university or institute funds) pay the salaries of professional scientists and professors, and all teaching costs. Basic hospital costs are paid in the case of clinical research. They also construct and maintain buildings -- often not well, but to some degree. In any event, the supplementary funds required specifically and solely for research are relatively minor, including such categories as special chemicals and laboratory supplies (glassware etc.), equipment, research animales and technicians. These items will typically amount to 10 to 15 percent of total research costs. Yet the one who can direct how this relatively small sum is spent can determine the course of research. This is how a small external investment has in the past exercised a strong influence over large segments of the health research program of a nation.

The ability of external bodies to exercise such strong influence over national research priorities has been resented (more often it is true by those concerned with national policies and goals than by the responsible scientists who have typically been glad to receive the external funds). Apart from preempting what should be national decisions, external funds often tend to create divisions between scientists who are happy to receive foreign funds and those who are concerned with national priorities.

Virtually all the United States research funds are supplied not to develop science in Latin America but to finance research of high scientific excellence that is relevant to the tasks of the various parts of the United States Government. They were, of course, extremely helpful to the individual investigators and to the laboratories receiving the funds. They also contributed to the development of science in the countries concerned. However, from the standpoint of the national policies of the Latin American countries, the fundamentals of the system itself were times questionable. For example, the United States grants and contracts were almost entirely for highly

sophisticated laboratory research. These fields are important in Latin America, but the characteristics of research supported from U.S. sources were not the same as would result from carefully considered national decisions made by the Latin American countries. Indeed, as another example, the United States funds were typically made to the individual investigator without reference to university or national authorities. This was often a distinct strength from the standpoint of science, because it protected the individual from various unproductive influences. However, the system made no provision for the consideration of needs broader than those seen by individual scientists.

Foreign research grants and contracts therefore have an extraordinarily powerful "leverage" effect since a small investment controls the direction and purpose of a much larger investment.

The tendency of outside research support to distort National priorities can exist in the case of foundation and international support. For example, this is why practically the entire research effort of at least one medical school is directed towards a single subject -- birth control. This poses in dramatic form the question of the extent to which the urgency of problems as contrasted with the merit of scientist would govern the allocation of funds.

6.4. Effects in specific countries

The long range beneficial effects of decreased support on external funding have been mentioned. However, these long range benefits are of no comfort to individual investigators and laboratories whose highly productive research has been disrupted by withdrawal of support. Latin American governments have not always provided support when some countries have a strong indigenous base of support which is relatively unaffected when foreign support is withdrawn. This has been the case with Venezuela, Brazil and Mexico. On ther other hand, the adverse affects have ranged from serious to disastrous in countries such as Argentina, Colombia and Chile. However, these difficulties, difficult as they are to dedicated scientists, many be inevitable in the transition to a fundamentally sounder form of support for health research in Latin America.

In Chile, the reduction of foreign support has been almost disastrous recently because of simultaneous reduction of outside funds and governmental funds. The work of many biomedical laboratories of first rate international quality has been badly impaired. The same is true in Peru and Uruguay but to a lesser degree.

In Argentina, the reduction in foreign support has had serious effects, but substantial funds have been available from internal sources, and there has not been a rapid increase in the numbers of highly qualified scientists. Because of the internal political situation and other factors, many qualified scientists have migrated to other countries.

In Colombia, the reduction in support for biomedical sciences has caused

difficulties for many laboratories, but the current reliance to a greater degree on indigenous sources is healthy. Moreover, outside support from the Kellogg Fund and other sources has continued to support fruitful investigations in the area of planning for the delivery of health care and for the training of health manpower.

In Mexico, Venezuela and Brazil, the reduction in outside support has not had serious effects. Each of these countries has a self sustained system of support for biomedical research. In none of these countries was there ever the degree of dependence on foreign support which typified some smaller and relatively poorer countries, although large amounts of help for biomedical research from foreign sources have been received by Brazil. In many fields -- genetics and biochemistry come to mind -- an initial impetus from outside has been followed by the development of strong scientists and strong laboratories financial with internal funds.

The situation in the British Caribbean has been unique. When support from the Rockefeller Foundation declined, the British government stepped in to ease the pain of transition. In effect, one outside source replaced another. The policy of the British government is to transfer financed responsibility for financing biomedical research to the University of the West Indies over a three year period. What will happen if the university does not assume this burden remains to be seen.

6.5. Implications for national policy

There is first, one policy which should not be adopted. Nations should not require national central approval for acceptance by scientists of funds from outside sources. The cure is worse than the disease. National central decisions on such matters are almost certain to be slow, arbitrary, bureaucratic and poorly informed.[1/]

The proper approach is a positive one. That is, countries should establish

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1/ There is an exception to this generalization. The British government will not provide funds for research in the British Caribbean unless the investigation has been reviewed by the Standing Advisory Committee for Medical Research of the British Caribbean. The arrangement works well, but special conditions prevail. The amount of research is small. Virtually all scientists in the area have easy access to the Committee, which is composed entirely of scientists. There are warm personal relationships between the officials in London and the leading scientists in the Caribbean.

general research policies which set reasonable priorities. These should be realistic, flexible, strongly invluenced but not dominated by scientists, and adequately funded. In such a situation, a country can guide its own destiny. It can then accept foreign funds for biomedical research, and even funds which are to be used for studies of interest to other countries, without distorting national priorities.

6.6. Continuing Needs for Outside Help

One important consequence of the decline of external support has been to stimulate thought on how the limited external funds can be used most effectively.

Basic to all kinds of foreign assistance is the spirit in which it is offered. The foreign assistance should be provided as a collaborative effort and not in a dominant or condescending manner. Realism requires recognition that nations act out of self interest, but long range self-interest can encompass sensitivity to the significance of human relationships. In the area of health research, a clear consensus has emerged that the general objective of external aid should be to help countries become self sufficient to conduct the kind of research on which they place highest priority. Within this general guidelines, specific areas of high importance are:

(a) Visiting professors and highly competent consultants are needed (either from the Unites States, Europe, Latin American countries or U.S. or European institutes a laboratories in Latin America, such as the Middle America Research Unit and the Gorgas Laboratory in Panama). Long term colleague relationships resting on a specific research program are the goal, and these have become very productive in the case of a number of well developed laboratories in Mexico, Venezuela, Brazil, Argentina, Chile, Peru and Colombia.

The danger to be avoided at all costs in such arrangements is what might be called "research imperialism". Few actions destroy good will more rapidly and effectively than a scientist from abroad who exploits local colleagues and

and locally collected research data. Investigators from the United States and Europ have at times exploited local investigators and resources without sharing data or credit.

(b) Funds to Meet Emergency Needs

Scientists in Latin America still depend heavily on foreign equipment and supplies for research. Often the work of an entire laboratory must cease because of a defective part in a piece of equipment, or because the stock of a given reagent or chemical has become depleted.

Funds in dollars or European currencies must be readily available to meet these high priority needs. One of the most serious effects of the reduction of outside research support has been to reduce the funds in foreign currency for such purposes.

In addition, the perennial problem of getting research equipment through local customs is still unsolved in many countries. As a consequence the benign sumggler -- the scientist from the United States or Europe who takes batteries, equipment parts and reagents through custom in his personal luggage to his colleague in Latin America -- remains on the scene.

(c) Seminars

Easy access to important areas of research while ideas are being formulated, and informal, current pre-publication on discussion of recent findings are of extreme importance to Latin American investigators. This is particularly true because they are not typically in the network of communication in the advanced countries which provides such information as a matter of course.

Therefore funds for seminars which typically require some dollar support are of dontinuing importance

(d) Continuing research support

Finally, the kind of support for research projects that has been provided by outside governments and foundations is welcome so long as it is provided in a context which does not result in de facto dictation of local research priorities.

This means that outside research support is most appropriate for those countries with relatively large and well financed biomedical research laboratories. (Is this the conclusion to which we are forced? It may be that for the smaller countries, a long range program to reinforce thir basic structure for science through training is in fact the best policy. This is the conclusion to which the OAS has come.)

In providing such assistance, what is required is a United States policy towards biomedical research in Latin America that is based not on the use of Latin American scientists and resources to further the objectives of the United States, but a policy which is based upon the development of biomedical research in and for Latin America. Only to a minor degree, and generally as a by-product, has the United States acted in the latter capacity.

Conversely, what is not desired is continuing support of research (and particularly professional salaries) on the basis of goals and priorities set externally.

Trend of Number and Amount of Research Grants Made by the National Institutes of Health of the United States to Latin American Countries, 1963 to 1972

(amounts in thousands of dollars)

	Total awards				Awards to PAHO				Awards to Individual Investigators and Laboratories			
Year	Number	Index	Amount	Index	Number	Index	Amount	Index	Number	Index	Amount	Index
1963	150	100	$2,848	100	18	100	$933	100	132	100	$1,915	100
1964	138	92	2,762	98	11	61	687	70	127	96	2,075	107
1965	138	92	2,734	96	13	72	714	72	125	95	2,020	106
1966	120	80	1,930	67	8	45	328	33	112	85	1,602	84
1967	108	72	1,839	63	4	22	340	34	104	79	1,499	79
1968	82	55	1,399	48	3	16	442	45	79	60	975	51
1969	62	41	1,366	47	4	45	528	53	58	44	838	44
1970	29	20	1,060	37	5	28	638	65	24	18	422	22
1971	22	15	1,048	36	3	16	717	72	19	14	331	17
1972	20	13	1,004	35	6	33	775	79	14	11	229	12

Number and Amount of Research Grants Made by the National Institutes of Health of the United States to Latin American Countries, 1963 and 1972

Research Grants	1963 No.	1963 Amount	1972 No.	1972 Amount
Latin America - Total	150	$2,849	20	$1,004
Argentina	21	356	6	102
Brazil	25	292	3	44
Chile	12	97	-	-
Colombia	3	87	2	57
Costa Rica	1	11	1	1
Educador	1	15	-	-
El Salvador	2	39	-	-
Mexico	24	422	1	22
Panama	1	22	-	-
Peru	13	363	-	-
Uruguay	7	116	1	3
Venezuela	4	96	-	-
PAHO	18	933	6	775

7. The Development of Regional Efforts

7.1. The Need for Regional Efforts

There is a fundamental need for Latin American countries to specialize, and to share specialized resources in health research. No country is large enough, wealthy enough and endowed with enough diversified, highly trained scientists and facilities to be completely self sufficient. This is simply a regional manifestation of a world-wide problem, a world-wide need and a world-wide opportunity.

The uneven distribution of resources is an opportunity and not a handicap. A more fully developed intellectual common market provides a means of developing indigenous talent in a manner that in the long run will decrease dependence on training outside Latin America and concentrate the use of resources for such training on those specific, highly specializes areas that are found in relatively few laboratories in the world. Conversely, the further development of unique centers of excellence in Latin America will make these few centers points of attraction for the scientists of the world.

A stronger intellectual common market will make it possible to train students to the utmost possible extent in Latin America. Expansion of the ability to use the excellent laboratories of Latin America to the fullest for the training of students who now go outside Latin America would provide important dividends of many different kinds. For example, more students would learn of the excellence of Latin American research centers, and the custom of looking first for study opportunities outside Latin America would be weakened.

7.2. The Shift Toward, Regional Cooperation

The past five years have in fact witnessed the development of more extensive more diversified and more effective forms of regional cooperation.

Development of the Idea of Regional Cooperation

The principle of regional cooperation has been recognized and enunciated by informed and influential groups for years. It was, for example, the subject of a specific recommendation by the OAS Science Advisory Committee at its first meeting

in 1958. The Committee proposed the "expansion of the support and activities of a relatively modest number of existing research institutes, with a view to using them as regional Centers of Research on an increasingly international basis."[1/] In 1959 the U.S. National Commission for UNESCO proposed that at least six regional research centers should be established, including centers for biophysics, biochemistry, and microbiology.[2/] First steps were taken in the direction recommended by these reports. For example, the Latin American Society for the Physiological Sciences has served as the agent to coordinate ten laboratories, and the Pan American Federation of Associations of Medical Schools has strongly urged this approach. In fact, a number of strong centers of research in Latin America have attracted and welcomed students and mature scientists. To take a couple of examples, between 1945 and 1964 the Outstanding National Institute of Cardiology in Mexico City welcomed 450 foreigners as specialists, professors, or investigators[3/] Of these, 350 came from other Latin American countries, 75 from Europe, 20 from the United States and Canada, and 5 from elsewhere. Other centers in Latin America, such as the Institute of Nutrition of Central America and Panama (INCAP) have a comparable experience, although on a smaller scale. In the Caribbean, the Trinidad Virus Research Laboratory has served for years as an important training ground for Latin American scientists and technicians in the field of virology.

During the past five years, one idea for the development of science in Latin America was born and died an unmourned death. This was a proposal to establish a large international technological university in Latin America to serve all of Latin America. Apart from such practical obstacles as the unwillingness of countries to fund the proposal and their inability to decide where it would be located, a more fundamental objection was raised. Such an institution would, if it were to be

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1/ The Organization of American States and the Development of Science, op. cit., p. 43.

2/ National Science Foundation, Science in the Americas: Papers Presented at the Scientific Section of the 7th National Conference of the U.S. National Commission for UNESCO, Denver, Colorado, 1959.

3/ The National Institute of Cardiology in 1964. On the Twentieth Anniversary of [illegible] Report by Dr. Ignacio Chavez, Founder and Honorary Director, p. 70.

successful, have destroyed virtually every productive laboratory in Latin America by taking away their intellectual leaders.

The debates leading to the early demise of the international technological university idea produced a positive alternative which is now developing slowly but firmly. That is, the establishment of networks of collaborating laboratories. In the health area, such networks have developed in biochemistry, genetics and food technology with the assistance of the OAS, and in clinical medicine, epidemiology, reproductive physiology, and nutrition under the auspices of PAHO. The extent and precise nature of these joint efforts differ among programs, but their general purposes and methods of operation are quite similar. They are first a mechanism for communication. Second, they often involve planned division of research effort. Third, they facilitate advanced training. Fourth, they are a means of making a larger functional whole out of smaller parts and thereby of over coming the problems generated by small scale and isolation.

It appears that the general strategy of enhancing collaborative efforts has replaced not only the abortive idea of a single/multi-national technological university, but also the specialized international center or institute. In earlier years, there was a tendency to set up centers or institutes as a means of putting advanced science in place quickly in countries and regions where science was weak. This in principle accounted for the establishment of the Rochefeller virus laboratories in Belem and Port-of-Spain, the Institute of Nutrition of Central America and Panama (INCAP) in Guatemala, the Goyas Memorial Laboratory and the Middle America Research Institute in Panama, and the PAHO Foot and Mouth Disease Laboratory in Brazil.

While these existing laboratories serve important functions, the set of circumstance which led to their establishment has passed the growth of indigenous science and has led to a shift of emphasis to strengthening national laboratories through collaborative efforts.

(This section to be rewritten and expanded after review by PAHO. Suggestions for changes are welcome.)

7.3 Pan American Health Organization

Among the international agencies, the Pan American Health Organization administers the most comprehensive program of support for health research in Latin America.[1/] This is the only international organization whose central function is the promotion of health. It has an unequalled reputation among international agencies for sustained technical excellence.

The PAHO research program consists of two parts -- laboratories financed and administered by PAHO itself and support for research conducted by scientists not affiliated with PAHO.

Between 1967 and 1970, the total research expenditures of PAHO increased by 15 percent from $3,156,000 to $3,642,000. (Table A) When increasing costs of research are taken into account, the expenditures have not increased in real terms.[2/]

In terms of the source of funds, the most significant development has been an increase in support from the PAHO budget from $581,000 to $1,085,000. PAHO supported 30 percent of the research program from its own budget in 1970, as contrasted with 18 percent in 1967. This percentage had increased substantially by 1973, but precise figures are not available. In spite of the decline in total support for health research in Latin America by the United States government, funds to PAHO remained virtually constant. Support from private foundations in the United States increased from $198,000 in 1967 to $446,000 in 1970. WHO provides modest funds to health research in Latin America through PAHO - $29,000 in 1970. "Other" support, which is primarily private foundations in England, amounted to $553,000 in 1970.

1/ This section relies heavily upon an excellent analysis of the PAHO research program prepared for the PAHO Advisory Committee on Medical Research by Dr. Franco Mortara, Review of the PAHO Research Program, 1962-1971. (PAHO, Washington, D.C.) PAHO/ACMR 10/4 Rev. 1, 67 pages.

2/ The absolute figures understate PAHO research expenditures because they do not include research undertaken by all parts of the organization. This is a deficiency which should be remedied.

When the PAHO research expenditures are examined by field, it is clear that the nutrition is by far the most significant area. In 1970, 37 percent of all research expenditure were devoted to this field, including the operation of a large center -- the Institute of Nutrition of Central America and Panama in Guatamala City. In absolute terms, $1,350,000 was expended for nutrition. The next largest expenditure (10.6 percent) was for the operation of the foot and mouth disease center in Brazil. A large child mortality study accounted for 10.1 percent of the expenditures, and studies of malaria for 8.3 percent. These four areas of study in total absorbed two thirds of the PAHO research expenditures.

Additional substantial proportions of the expenditures were accounted for by biomedical communications and the regional library (5.6 percent), research development and coordination (4.1 percent), the health planning center (3.5 percent), and the perinatology center (3.4 percent).

In assessing this division by field, a number of factors must be borne in mind. The distribution of the PAHO research effort need not be proportioned to the importance of various health problems in Latin America. The fact that a health problems is serious in Latin America does not necessarily mean that it should be financed by PAHO. Other national and international resources are devoted to health research, and the PAHO program is designed to **complement other funds and to provide "seed money."**
are not yet amenable to research, and some research is better done in places other than Latin America. Finally, the total PAHO research effort should not be judged solely upon how much money it disburses for research.

In assessing the PAHO research program, functions other than provision of funds for support of research must be emphasized. It is the major mechanism through which scientists engaged in health research consult on common problems. The Organization is a respected mechanism for organizing multinational research efforts. It is the major agency for exploration of the feasibility and desirability of research in neglected areas. Areas deliberately and effectively stimulated by PAHO include

immunology, epidemiology, mycoses, clinical research, goiter, the arbor viruses, the physiology of reproduction and health planning. PAHO is the major agency responsible for calling to the attention of governments the significance of health research. It, together with WHO, is the only international agency with a continuing and extensive interest in health research broadly defined to include research in such fields as administration of health services, hospital and clinic administration, national health planning, epidemiology and biometry, improvement of communications and training for health research. PAHO is the major intermediary between many external sources of funds for health research and/investigators in Latin America. The experience and status of the organization have made it an effective instrument for the planning and administration of research financed by others.

Unresolved Problems

Despite the breadth of the PAHO research program, it is still inadequate in a number of respects.

First, a high proportion of the research funds supplied by the PAHO budget is devoted to the operation of laboratories financed almost entirely by PAHO. These are the Institute of Nutrition of Central America and Panama (INCAP) and the Foot and Mouth Disease Laboratory. While these institutions are productive, the funds allocated to them inhibit expenditures for diversified support of research on problems of great significance.

Second, about 70 percent of the support provided by PAHO comes from sources other than the budget of the organization itself. This means that the research priorities of PAHO are in fact strongly influenced, and in some cases determined, by organizations which have other priorities. This tends to frustrate efforts to construct a plan of research that is rationally related to the needs of the region. Third, research on many important problems is not financed by PAHO. The neglected areas include venereal diseases, plague, poliomyelitis,

diptheria, pertussis tetanus and onchocerciasis. Little research on these diseases is supported by other agencies. While PAHO provides a small amount for research on Chagas disease and other sources of support also supply funds, the total regional research effort related to this disease is clearly inadequate, and many urgent research problems amenable to solution exist. These problems include comparative studies of the effectiveness of insecticides, studies of housing in relation to the disease vector and a simple diagnostic test.

These gaps in research are primarily a reflection not of poor planning by PAHO, but of the unwillingness of the member states to contribute funds adequate to support a PAHO research program adequate to complement other national and international efforts.

Table A Source of Funds for the PAHO Research Program, 1967 and 1970

(in thousands of dollars)

Source	1967		1970	
	Amount	Percent	Amount	Percent
Total	3,156	100	3,642	100
PAHO Budget	581	18	1,085	30
United States	1,665	53	1,875	51
Government	1,467	46	1,429	39
Private	198	7	446	12
WHO[1/]	910	29	129	4
Other[1/]			553	15

1/ WHO and Other not separately tabulated in 1967.

Table B. PAHO Research Expenditures

by Field, 1967 and 1970

Subject	Percent of Total 1967	1970
Total	100.0	100.0
Nutrition (INCAP and other)	38.6	37.0
Foot-and-mouth disease	17.9	10.6
Child mortality study	--	10.1
Reference centers and research training	9.3	--
Malaria	8.4	8.3
Zoonoses	6.4	3.1
Biomedical communications and regional library	6.0	5.6
Research development and coordination	--	4.1
Health planning center	--	3.5
Perinatology Center	--	3.4
Studies of health services	--	2.7
Dental health	1.9	--
Environmental sciences and engineering	1.8	--
Endemic goiter	1.8	--
Health statistics	1.8	--
Arboviruses, and other virus diseases	1.6	--
Aedes Aegypti control	--	1.5
Maternal and child health	1.2	--
Occupational health	.9	2.2
Other	3.5[1/]	3.5[2/]

1/ Health manpower, mental health, cancer, sereoepidemiology, and Chagas' disease. (Each category less than 1%)

2/ Mycology, toxicology of pesticides, preventive medicine, plague, research training and other. (Each category less than 1%.)

7.4. Organization of American States

In the Declaration of the Presidents of the American States at Punta Del Este in 1967, science and technology were explicitly recognized for the first time by heads of governments as important to development. As a direct consequence of that declaration, the Organization of American States developed a Regional Program for Scientific Development. The program is designed to lift science and technology to levels which will accelerate economic development and the well being of people, to complement national programs, to strengthen science education, the education of scientists and the diffusion of information, and to promote the transfer of technology to Latin America. The program is designed for science and technology as a whole, rather than for health research. However, a number of activities under the program are related to health.

In total, the program is quite extensive and growing as indicated by these figures:

(millions of dollars)

	1969[1/]	1970	1971	1972	1973[2/]	Total[2/]
Total	1.7	4.6	5.0	6.2	3.9	21.4
Multinational projects	1.3	3.2	3.6	4.7	3.1	15.9
Reinforcing existing laboratories	.3	1.1	.7	.8	.5	3.4
Basic studies	.1	.3	.7	.7	.3	2.1

Exchange of students and professors over the periods 1969-1973 was also quite extensive.

International fellowships	1707	417
Exchange of scientists	844	134

The three areas relevant to health in the OAS program are genetics, food and nutrition, and biochemistry. In each of these programs, a network of collaborating

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1/ All years ending June 30

2/ Up to March 1973

laboratories, consisting of the leading laboratories in the region, has been set up. These laboratories plan joint research, exchange investigator and students, foster graduate education of high quality closely linked to research, share expensive equipment and data, and organize international research seminars.

The scope of the effort is indicated by the fact that 16 departments and institutes in 6 countries are collaborating in the biochemical effort;[1/] and 12 laboratories in 10 countries are collaborating in food technology; 8 laboratories in 5 countries are participating in the genetics program. A further measure is the investment of funds, exchange of professors and fellowships:

(in thousand of dollars)

Multinational Project	Total Funds	Visiting Scientists No.	Visiting Scientists Amt.	Fellowships No.	Fellowships Amt.	Equipment Grants
Total	2,765	170	450	343	935	1,380
Biochemistry	780	60	135	103	255	390
Genetics	560	34	115	105	280	165
Food Technology	1,425	76	200	135	400	825

1/ For example, the collaborating laboratories in biochemistry are:

Argentina

Consortium composed of:
- Instituto de Investigaciones Bioquimicas
  Fundacion Campomar
  Buenos Aires
- Departamento de Quimica Organica
  Facultad de Farmacia y Bioquimica
  Universidad de Buenos Aires
- Instituto de Quimica Biologica
  Facultad de Medicina
  Universidad de Buenos Aires

Brasil

Consortium composed of:
- Departamento de Bioquimica
  Instituto de Quimica
  Universidade de Sao Paulo
- Instituto de Bioquimica
  Universidade Federal de Parana
- Departamento de Bioquimica
  Instituto de Quimica
  Universidade Federal do Rio de Janeiro
- Departamento de Bioquimica
  Instituto de Biociencias
  Universidade Federal de Minas Gerais
- Departamento de Bioquimica e Biofisica
  Escola Paulista de Medicina

Chile

Consortium composed of:
- Departamento de Bioquimica y Quimica
  Facultad de Medicina
  Universidad de Chile
  Santiago
- Departamento de Quimica Biologica
  Facultad de Quimica y Farmacia
  Universidad de Chile
  Santiago

Mexico

Consortium composed of:
- Departamento de Bioquimica
  Facultad de Medicina
  Universidad Nacional Autonoma de Mexic (UNAM)
  Mexico, D.F.
- Departamento de Bioquimica
  Centro de Investigaciones y Estudios Avanzados
  Instituto Politecnico Nacional (IPN)
  Mexico, D.F.

Peru

Consortium composed of:

-Instituto de Bioquimica y Nutricion
Departamento de Bioquimica y Fisiologia
Universidad Nacional Mayor de San Marcos
Lima

-Laboratorio de Bioquimica
Instituto de Biologia Andina
Universidad Nacional Mayor de San Marcos;

-Laboratorio de Bioquimica
Instituto Veterinario de Investigaciones
Tropicales y de Altura
Universidad Nacional de San Marcos, Lima

Venezuela

-Departamento de Bioquimica
Instituto Venezolano de Investigaciones
Cientificas (IVIC)

7.5. Interamerican Development Bank

The Interamerican Development Bank (Banco Interamericano de Desarrollo) has been a helpful factor in the development of health research in the region because of its enlightened policy of assisting with the financing of higher education and research as factors important to the process of economic and social development. The Bank has concentrated upon the institutional development of universities, but with a substantial emphasis on science. The Bank has not invested substantially in the development of multi-national consortio. The scale of its efforts is indicated by this table, which indicates the total bank investment from 1960 through April 1972.

(in thousands of dollars)

Country	Total	All Sciences[1/]	Health Sciences	Education	General[2/]
Total	210,710	124,767	12,675	51,119	34,824
Argentina	61,800	33.736	3,800	28,064	-
Chile	29,900	21,340	1,740	1,160	7,400
Colombia	22,200	10,964	10	320	10,916
Haiti	1,300	955	325	345	-
Honduras	7,950	6,618	4,800	-	1,332
Regional	2,000	2,000	2,000	-	-
All other	85,560	49,154	-	21,230	15,176

1/ Including health sciences

2/ Equipment construction etc. not assigned to either science or education.

Source: Banco Interamericano de Desarrollo.

Fomento de la Education, la Ciencia y la Tecnologia. Washington, D.C. April 30, 1972, p. 7 **(Mimeographed)**

It can be seen that the investment of $12,675,000 represented 6 percent of the total Bank investment of $210,710,000 in science and education, and that the health sciences investment was concentrated heavily in four countries -- Honduras, Argentina, Chile and Haiti. However, the health sciences benefitted indirectly from the assistance of the Bank to other areas of science.

7.6. Conclusion

The most significant development in health research in Latin America over the past five years has been a shift away from nation-to-nation support of biomedical research to a variety of approaches to regional cooperative networks. The idea of establishing a super-university was wisely abandoned in form of strengthening existing laboratories and fostering collaboration among them. At the same time, the earliest concept of establishing specialized research centers (by governments outside the region, by foundation or by international agencies) as physical entities by outside existing laboratories has been sharply questioned. Again, the trend is towards strengthening existing national laboratories and towards cooperation among them.

The development of regional cooperative networks rests on a foundation of earlier efforts. A productive network must rest on competent individual laboratories. A minimum number of fully mature investigators must exist. A habit of cooperation must develop. The national and international political situation must be such that cooperative efforts are fostered and adequately financed. A minimum administrative structure must exist to make the collaboration effective. All of these things take time, and they did not reach adequate stage of function until recently.

Pooling of resources is being made more effective through such measures as more pointed and organized efforts to identify, through common agreement, those institutions, universities, faculties, laboratories, institutes, schools, or whatever they might be that have special competence in given fields of graduate education and research in health.

With respect to education, more extensive organized efforts are being exerted to send students from various countries to these centers for advanced training and research experience. The selected centers are, in turn, benefiting from the presence of excellent advanced students from a number of countries. Those who completed advanced training will predictably be leaders in later years in their own countries.

With respect to research, the strong centers in various countries in selected fields are serving as a framework for the development of investigation on a broader basis than is possible when the laboratories are not closely related. Laboratories, and individual scientists, do retain their individuality and the capacity to carry out their own ideas. But easy association of investigators and students with colleagues in other laboratories is providing a strong stimulus to the development of ideas.

Appendix I

Health Research Defined

Health research is for this report divided into two categories. First, there is the area of biomedical research which includes investigation which contributed to an understanding of the normal/life processes of man and to the **and abnormal** treatment and prevention of disease states, which may be looked upon as absnormal life processes of man. Second, there is the area of what might be called public health research which encompasses investigation of environmental factors that affect the health of populations.

A. Biomedical Research

Biomedical research includes both the clinical sciences **that are directly related to medicine and research in the basic sciences, that is, the biological, physical, and behavioral sciences.**

The limit on one side may be very clinical in nature and involve studies in which the research problem is related to an illness of a patient. Such studies have come to be called clinical investigation. This may involve the kind of close physician-patient relationship that might prevail during an intensive study of a patient's illness under controlled conditions for the purpose of making a critical clinical observation. However, this is perhaps the most elementary effort describable as a clinical investigation. More typically, clinical investigation is represented by a situation in which the illness is studied in the laboratory without the close physician-patient relationship just alluded to and instead all aspects of science and actual collaboration with basic scientists are brought to bear on the clinical problem. In these oversimplified examples, cinical investigation is characterized by controlled studies and the application of the scientific method to clinical problems. Although patient or medical care may be involved, their involvement is only incidental to the studies and is not a requisite of clinical investigation.

The limit on the other side is represented by the basic sciences exemplified by mathematics, physics, and chemistry and the relatively new disciplines such as biophysics, molecular biology, and mathematical biology that have recently evolved from them. Although these sciences are not in their entirety classified as biomedical science, the techniques, theory, and concepts of the physical sciences and the work of personnel trained in them have been brought to bear on clinical and biological aspects of the study of man in health and in disease.

B. Public Health Research

Public health research encompasses a broad and complex area of study which concentrates not on the health and illness of individuals, nor on the basic biological sciences themselves, but on the factors in the environment which influence the health of groups of people. Included in this area are studies of the resources available for protection of health and the effectiveness with which these resources are organized and used, the cultural factors (food preferences, for example) which influence health, the effects of housing, diet, transportation and clothing on health, the effects of the availability of water on health, sewage and garbage disposal as factors affecting health, investigations of mortality and morbidity in population groups as a guide to causation prevention and treatment of disease or other factors adversely affecting health.

In Latin America, these areas of study are of special importance because they relate, by and large, to means by which maximum effects on health levels may be exerted with minimum expenditures per person.

Biomedical research and public health research are obviously interrelated. For example, vaccination programs are not likely to be effective if a vaccine does not exist, and biomedical research is necessary to produce vaccines. Conversely, precise knowledge of the needs of the human body for protein, knowledge gained only by biomedical research, is in the long run sterile unless the knowledge can be put to use, and for this public health research is required.