SEMINAR ON THE TEACHING OF PREVENTIVE MEDICINE and PUBLIC HEALTH in

Schools of Veterinary Medicine

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
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SEMINAR ON THE TEACHING OF PREVENTIVE MEDICINE AND PUBLIC HEALTH IN SCHOOLS OF VETERINARY MEDICINE

(Mexico City, Mexico, 25-31 August 1963)

With an appended report on the first meeting of the Seminar Coordinating Committee (Chapel Hill, North Carolina, 19-21 October 1964)

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INTRODUCTION

In the countries of the Americas the teaching of veterinary medicine, before 1940, was concerned almost exclusively with the training of clinical veterinarians. Since that time, increasing emphasis has been laid on the need for including in the veterinary curriculum more instruction in public health and preventive medicine, and greater importance has also been given to the utilization of epidemiological methods for combating zoonotic diseases.

At the First Seminar on the Teaching of Public Health and Preventive Medicine in Schools of Veterinary Medicine in the Americas, held in August 1959 in Kansas City, Missouri, recognition was given to the fact that, through the incorporation of the veterinarian in the public health team, the veterinary profession had acquired a new dimension and was assuming a truly social function.

At that meeting, the participants sought to define, in general terms, how the veterinarian might best fulfill his relatively new dual role, as a member of the profession and a member of the community. Because of the broadening scope of veterinary medicine and its close relationship to general medicine, sanitation, and public health engineering, the need was stressed for giving more public health training to the veterinary student. Among the recommendations of the Kansas City Seminar were the following:

1. Concepts of preventive medicine should be developed to the maximum in all phases of the veterinary medicine curriculum.

2. Whenever possible, public health subjects should be included in the curriculum, in order to give instruction in and to coordinate the veterinary aspects of public health, both in special courses and throughout the program of studies.

3. It is necessary to develop in the student of veterinary medicine an ethical concept of public service and an awareness of his responsibility toward the community.

It is now possible to demonstrate the progress that has been achieved in the teaching of public health and preventive medicine since the Kansas City Seminar. The problem confronting the schools of veterinary medicine in the Americas is no longer one of concept but one of degree—how much and when public health should be taught to the veterinary student, who should teach it, and how it should be incorporated in the program of studies.

Veterinary medicine—as a component of economic development in the Americas, and as an educational force in a rapidly progressing society—must fill the ever-increasing demand for well-qualified veterinary physicians properly grounded in public health. The responsibility for training and guiding veterinarians falls primarily on the schools of veterinary medicine, and those schools are increasingly aware of society's changing needs and of the responsibility they have in meeting them.

In April 1953, a questionnaire on the teaching of public health was sent by the Pan American Sanitary Bureau to the deans of 50 veterinary medicine schools in the Hemisphere. Replies received from 43 schools showed that 35 of them (82 per cent) included a public health course in their curricula, and that five schools incorporated public health instruction in other subjects. Thus, public health was being taught in 40 of the 43 schools (93 per cent). The average annual number of hours assigned to this instruction ranged from 108 in the United States and Canada, to 130 in certain schools in Latin America.

The questionnaire replies indicated that a

total of 30 schools (19 in Latin America and 11 in the United States) taught the basic principles of public health during the last year of veterinary studies. This instruction comprised a full-year course in 25 schools; in nine it was given during a semester; and in four U.S. schools it was given for a three-month school term. Two U.S. schools and four Latin American schools did not include instruction in public health in the curriculum but considered it to be covered under related subjects. Nine schools in Latin America had one full-time professor of public health who headed the school's public health department; in the United States 11 schools had full-time professors. Eleven of the public health professors in the Latin American schools, and 12 in the U.S. schools, had an M.P.H. degree.

In 1963 a total of 8,195 students were enrolled in veterinary medicine schools: 1,707 in the United States, 100 in Canada, and 6,388 in Latin America. In the same year, 2,488 students entered the first-year course and a total of 914 were graduated (416 in the United States and 495 in Latin America). Complete information could not be obtained on the number of veterinarians who continued their studies for the M.P.H. degree after graduation. Incomplete questionnaire data for Latin America revealed that only 60 veterinarians took graduate public health courses; those professionals were working in the following fields: university and education, 18; public health institutions, 25; agriculture, 3; international public health 2; research, 1; military veterinary medicine, 2; commercial firms, 6; not specified, 3. Similar information for the United States and Canada, also incomplete, was as follows: university and education, 12; public health institutions, 21; agriculture, 6; military veterinary medicine, 2; international public health, 3.

There were, in addition, more than 37 veterinarians with M.P.H. degrees, whose field of activity was not indicated in the replies. It is interesting to note that in the public health schools in the United States, 17 veterinarians were associate or assistant professors.

At the beginning of the 1963 scholastic year, 53 veterinary physicians applied for admission to U.S. public health schools and 43 were accepted. Only five registered in public health schools in Latin America.

Thus, the questionnaire data indicated the progress made in the teaching of public health in veterinary medicine schools since the time of the Kansas City Seminar, when the subject was taught in only 25 per cent of the schools and there was a public health course in only a few.

The Pan American Sanitary Bureau made the arrangements for the Second Seminar on the Teaching of Public Health and Preventive Medicine, with the aim of evaluating the benefits of the First Seminar and of giving further stimulus to the teaching and the application of those disciplines. For this purpose it sought the participation of public health professors from veterinary schools throughout the Americas. The agenda focused primary attention on the incorporation of the teaching of public health in the curriculum, in order to promote the widest possible discussion by those experienced in the matter and those who could derive benefit from this exchange. The main agenda topics were as follows:

1. Public Health in General
2. Epidemiology and Control of Disease
3. Food Hygiene
4. Teaching of Statistical Methods and Their Application
5. Curriculum Content

ORGANIZATION AND CONDUCT OF THE SEMINAR

Arrangements for the Seminar were begun in February 1963. The National Autonomous University of Mexico graciously made available for the meeting the premises of its School of Veterinary Medicine and Zootechnics. Invitations were extended in March

1963 to the ministers of foreign affairs and of public health of the various countries, and to the deans and the public health professors of all schools of veterinary medicine in the Americas. The Pan American Sanitary Bureau invited prominent health specialists as consultants to prepare working documents as the basis for discussion of the agenda items.

Thirty veterinary schools were represented: 21 in Latin America, eight in the United States, and one in Canada. Four representatives from the public health services of Mexico, two from the health services of the United States, and three from the Ministry of Livestock of Mexico also participated. Dr. E. H. Andersen, of the Food and Agriculture Organization of the United Nations, attended as observer.

The inaugural session was held at the Science Auditorium of the National Autonomous University of Mexico on 25 August 1963. The inaugural address was delivered by the Dean of the University, Dr. Ignacio Chávez, who presided at the session. Addresses were also delivered by Dr. José Alvarez Amézquita, Secretary of Health and Welfare of Mexico; by Dr. Constantino Brandariz, Dean of the School of Veterinary Sciences, National University of La Plata, Argentina; and by Dr. Guillermo E. Samamé, Chief of Zone II Office, Pan American Sanitary Bureau.

The five main topics were presented at six plenary sessions. After the presentation of the topic for each day, the participants met separately in three working parties where each agenda item was discussed. The working parties elected a moderator and a rapporteur for each day so that no one participant would be unduly burdened by those responsibilities. On the basis of the working parties' reports, the coordinating committee prepared the joint report of the Seminar, which was discussed and approved at the closing plenary session, held on 31 August.

A proposal was approved at the closing session for the establishment of a Seminar Coordinating Committee, designed to give continuity to the work initiated at the two Seminars, to offer guidance to the different schools for the implementation of the Seminars' conclusions, and to serve as an advisory committee of the Pan American Sanitary Bureau for the planning of future Seminars.*

In bringing the activities of the Seminar to a close, Dr. José Alvarez Amézquita, Secretary of Health and Welfare of Mexico, praised the enthusiasm and dedication of the participants and expressed satisfaction with the conclusions and recommendations of the meeting, which would make a contribution toward the socioeconomic improvement and well-being of the peoples of the Hemisphere. He expressed the hope that all the participants, on returning to their countries, would disseminate the ideas and the experience exchanged during the Seminar.

On behalf of the Pan American Sanitary Bureau, Dr. Carlos Díaz-Coller, Chief of the Professional Education Branch, expressed appreciation to the Ministry of Health and Welfare of Mexico, to the National Autonomous University, and to the Social Security Institute for their contribution to the Seminar, and expressed the Bureau's pleasure at having been able to offer the opportunity for exchanging ideas on the teaching of public health and for establishing personal contacts that would be fruitful in the future. He emphasized that the conclusions and recommendations of the meeting should not remain a mere document but rather should serve as the basis for new accomplishments. Dr. Manuel Ramírez Valenzuela, Director of the School of Veterinary Medicine and Zootechnics of the National University of Mexico, stressed the fact that the adoption of general standards for the teaching of public health represented a tremendous step forward which not only would raise the veterinarian's professional status but would have economic repercussions through the increase in livestock. Dr.

* The report of the first meeting of the Seminar Coordinating Committee (Chapel Hill, North Carolina, 19-21 October 1964) appears in the appendix to this publication (see pp. 85-91).

Daniel Cohen, Assistant Professor of Epidemiology and Public Health, School of Veterinary Medicine of the University of Pennsylvania, expressed satisfaction at having had the opportunity to learn of the Hemisphere's veterinary public health problems; he stated that the Seminar had produced excellent results, and that they would all look forward with interest to the next meeting.

The participants were agreed that no uniform plan of studies should be recommended, but that for the teaching of public health a "preventive medicine" and "public health" unit (department, institute, chair, etc.) should be established.

It was recommended that the professor heading the unit should, wherever possible, be a veterinary physician trained and experienced in public health and employed on a full-time basis.

The unit, in its teaching activities, should make full use of educational facilities available in other institutions (laboratories, medical schools, public health services, etc.).

To promote the interchange of information on teaching methods and media, it was recommended that the Pan American Sanitry Bureau distribute in the near future reference data on the current plans of study in preventive medicine and public health and related subjects in veterinary schools in the Americas. For the teaching of public health administration and the behavioral sciences, it was considered necessary to include practical studies that would put the student in touch with the real problems of the community.

Finally, the participants were agreed that the principles of statistics should be taught in the early stages of the veterinary curriculum, along with the basic sciences; that epidemiological methods should be taught in the intermediate stage; and that the applied studies in both those disciplines, along with the specific public health studies, should be taught in the last part of the veterinary course.

FINAL REPORT

ESTABLISHMENT OF A SEMINAR COORDINATING COMMITTEE

At the First Seminar on the Teaching of Preventive Medicine and Public Health in Schools of Veterinary Medicine in the Americas, held in Kansas City, Missouri, in August 1959, full recognition was given to the need for including instruction in public health in the veterinary medicine curriculum. The Second Seminar reaffirmed this need and recommended that the Pan American Sanitary Bureau establish a Coordinating Committee for Seminars on the Teaching of Preventive Medicine and Public Health, to evaluate the progress achieved in carrying out the recommendations of these meetings and to collaborate in the organization of future Seminars.*

GENERAL CONCLUSIONS AND RECOMMENDATIONS

The teaching of public health in schools of veterinary medicine has become an important aspect of veterinary education. In this connection, emphasis should be given to the needs of the public health services, which require the collaboration of veterinarians in the health programs they conduct in both urban and rural areas.

Certain veterinary medicine schools have, nevertheless, failed to recognize that public health should be taught in the school in a separate course, subject, or department. All schools are urged to adopt a positive approach in this matter, in order that the basic studies may be oriented toward preventive medicine and public health, and that the students may acquire a sense of social responsibility in the practice of their profession. In the same way, encouragement can be given to the veterinarian to develop his potentialities for contributing to the economic welfare and for assisting in the protection and development of the livestock industry.

The teaching of public health to the practicing veterinarian equips this professional to better serve his own clients and to render greater assistance to the community in which he lives, either through service in the local health departments or in discharging functions in the official agricultural agencies that may request his services.

The fulfillment of this need represents a challenge not only to the public health professors, but to the deans and entire faculty of veterinary medicine schools throughout the Americas.

ACKNOWLEDGMENTS

The Seminar expressed its appreciation to the National Autonomous University of Mexico and the School of Veterinary Medicine and Zootechnics for their generous cooperation, and to Dr. José Alvarez Amézquita, Secretary of Health and Welfare of Mexico, for his assistance and advice. The Ministry of Health and Welfare of Mexico authorized the participation in the meeting of the directors of health education and of rural medical services, cooperatives, and sanitation and community development services, thereby giving the other partici-

* The report of the first meeting of the Coordinating Committee appears in the appendix to this publication (see pp. 85-91).

pants the benefit of their experience in the veterinary aspects of community health programs. A vote of thanks was extended to the Pan American Sanitary Bureau for having sponsored the Seminars, which have brought great benefit to public health through the study and discussion of major topics in this field, and which have given much satisfaction to a profession that has always held a close relationship to public health.

JOINT REPORT OF THE WORKING PARTIES

I. PUBLIC HEALTH IN GENERAL

In the past four years, it has been possible to observe the benefits derived from the First Seminar on the Teaching of Preventive Medicine and Public Health in Schools of Veterinary Medicine in the Americas, held in Kansas City in 1959. It is considered necessary to maintain the interest which that meeting aroused in the teaching of these subjects in veterinary schools.

Not all of the recommendations of the First Seminar have been put fully into effect, and it is therefore essential to reiterate the need for implementing those measures.

The establishment of courses in public health in many veterinary medicine schools in the Hemisphere has filled a deeply felt need in the education of the veterinarian, and has contributed to community welfare.

It is again pointed out that the activities of the veterinarian, in whatever specialty or field he may be engaged, are an indispensable factor in the achievement, maintenance, and promotion of public health.

With regard to the emphasis that should be placed on the teaching of preventive medicine and public health in veterinary medicine schools, it is considered that all veterinarians should have a basic knowledge of public health. The schools should organize their plans and curricula in such a way as to form in the students the attitude and skills that will enable them to make an effective contribution to the programs of public health.

Without prejudice to other curriculum courses that include instruction in public health, it is recommended that schools of veterinary medicine establish teaching and research units (chair, course, or department) for the purpose of organizing and coordinating the teaching of this subject, and developing the students' knowledge and understanding of the concepts of public health. It is recognized that the specialists in veterinary public health should be trained in the school of public health.

As a professional in public health, the veterinarian is well equipped to direct, coordinate, or carry out functions connected with the production, technical processing and control of foods, the control of zoonoses, and comparative medicine. Among his functions and responsibilities are the following:

1. Promotion of public health in rural and urban areas through activities for the prevention and control of diseases and infections transmitted directly or indirectly through foodstuffs or by insects and other animals to man.

2. Epidemiological studies and assessment of risks to public health and problems that may arise in connection with animal diseases.

3. Reporting of diseases transmissible from animals to man.

4. Participation in the planning, promotion, coordination, and supervision of programs related to nutrition (of man and of animals), food production, and food hygiene.

5. Planning of, and participation in, laboratory and field research on comparative medicine and on laboratory animals.

6. Active participation in the identification of hazards of radiation to human and animal health.

7. Participation in environmental health programs.

8. Collaboration in the development of "space" medicine.

9. Participation in medical work during disasters and public calamities.

10. Active participation in health education, especially in rural areas.

11. Advisory services and participation in the drafting of legislation and regulations or ordinances related to the special fields and services of veterinary medicine.

II. EPIDEMIOLOGY AND CONTROL OF DISEASE

It is considered essential that epidemiology be taught in schools of veterinary medicine, since it is basic to the study and understanding of problems related to community health and disease.

In order to give proper emphasis to the teaching of epidemiology in veterinary medicine schools, it is recommended that, whenever possible, its principles be taught in the first stages of the curriculum, by a professor or assistant professor who has received special training in this discipline. Epidemiology should thus be taught as a separate course. This need not prevent the teaching of applied epidemiology in later courses. As a prerequisite for the study of epidemiology, the student should have a knowledge of biostatistics.

It is considered that not only could students of veterinary medicine study basic epidemiology in conjunction with students of other allied professions, but also that this might be advisable under certain circumstances. However, applied epidemiology should be taught separately. It should also be recognized that epidemiology is taught most effectively in small groups, and the necessary arrangements should be made for doing so.

Preferably, the professor of epidemiology should be a veterinarian. But it is also important that the individual be specialized in his subject and be able to teach the course properly. Therefore, in some cases it may be necessary to utilize professors with other professional background until veterinarians are properly trained for the assignment.

The epidemiological principles used in the study of the diseases of man are fully applicable to the study of animal diseases. Their application depends on a knowledge of the characteristics of the specific population exposed to risk. Thus, it is necessary to promote the compilation of data on the size and composition of the animal population, the reporting of communicable diseases, and the study of the characteristics of diseases that affect various species, including the extent of the involvement of wildlife.

The instruction in epidemiology should provide the student with sufficient and properly organized information, and the student should carry out laboratory and field practice in order to develop the necessary aptitude and skill in the use of the scientific method of trial and error.

Although emphasis should be given to the application of epidemiology to all animal diseases, special attention should be paid to the zoonoses, and human diseases that provide clear examples of epidemiological principles may also be subjects of study.

III. FOOD HYGIENE

The importance of foods of animal origin to the well-being of man is clearly understood, as is also the fact that the veterinarian plays a key role in activities designed to assure the abundance, quality, and hygienic control of those foods.

The veterinarian's participation in the work of food control and hygiene also gives him a better understanding of the pathological conditions and normal variations that occur in animals.

Food hygiene, moreover, affords excellent opportunities for preventing the transmission of zoonoses and other diseases through foodstuffs, and furnishes epidemiological data useful for detecting foci of disease.

The inspection of foods of animal origin also serves as a measure for evaluating the results of animal disease control programs.

Such foods are prime media for the propagation and multiplication of pathogens, which may result in contamination during the stages of processing, manufacturing, packaging, storage, and sale. Human diseases not included in the zoonoses group represent a serious hazard in the complex process of food handling. These dangers can be greatly reduced through proper food hygiene.

Application of the principles and practices of food hygiene, on the other hand, has direct repercussions on the economy of the countries, cutting down waste of valuable foods and providing a stimulus to production.

For these reasons, the veterinarian not only bears a great responsibility in the programs of food hygiene, but should assume leadership in this field. Veterinary medicine schools, in turn, have responsibility for providing properly trained professionals to discharge this function.

In their teaching programs, schools must effectively cover the fundamentals of microbiology, parasitology, food inspection, and other subjects necessary to give the students a full grasp of the requirements in the field of food hygiene. Teachers should emphasize the interrelationships between foods and the sociocultural conditions of food handlers, the ecologic environment (surrounding area and premises, equipment, vectors), and related factors.

Advances in technology have made food hygiene a highly specialized field, and the subject is a very complex one for students of veterinary medicine. The latter should nevertheless have sufficient knowledge to enable them to understand the methods of processing and the equipment used in the food industry.

They should also be aware of the possibilities of contamination, fraud, adulteration, whether intentional or accidental, and be familiar with the methods for preventing and controlling such risks.

They should learn of the importance of residual substances present in foods of animal origin, the value of antibiotics in the production of foods, as well as their possible harmful effects on human health, and the risks in connection with hormones, pesticides, insecticides, fungicides, and other substances.

Finally, to properly fulfill these and other responsibilities, the future veterinarian should be versed in the principles of education of the public.

IV. TEACHING OF STATISTICAL METHODS AND THEIR APPLICATION

The student of veterinary medicine should be taught the basic principles and fundamentals of statistics, so that he will know how to obtain essential statistical information, to communicate with members of other professions, and to compile data on both the healthy and the sick population, the environment, and agents of disease, for use in his professional practice and in scientific research.

The statistical method provides the elements for the proper collection, evaluation,

and presentation of scientific data, aids the student in developing a scientific approach to his work, and facilitates his reading, understanding, and appraisal of scientific literature.

Since statistics is an exact science, emphasis must be given to the need for obtaining reliable data. The advice of persons specialized in this field should be sought as required, so that the future veterinarian will know how to search for, select, and utilize the best statistical sources, both in his practice and in research.

Ideally, the basic course in statistical methodology should be given in the first years of the curriculum, or even as part of the pre-professional studies, where they exist. The course should teach the student the fundamentals of statistical methods and their application.

It is recognized that mathematical preparation is a prerequisite for the course in statistics, and that the basic principles and methods of statistics may be imparted in other courses. However, biostatistics should preferably be given a specific place in the study program, whether taught in a special course or together with epidemiology.

The student should be made aware of the fact that the collection of statistical data by government agencies is in different stages of development, and of the need for proper reporting, registration, tabulation, and interpretation of data, as well as for the full collaboration of those agencies with other official services. Likewise, it is essential that government agencies organize statistical services in such a way as to have maximum value for the user.

The student should be encouraged to continue to apply his knowledge of statistics throughout his professional life, and to keep constantly in mind the importance of providing reliable data.

Finally, it is considered advisable that schools of veterinary medicine organize for the faculty members courses in statistics given by trained specialists.

V. CURRICULUM CONTENT

It is considered that, without prejudice to the topics that have been specifically recommended, certain other important areas in the curriculum merit special attention in relation to public health, it being understood that throughout the entire study program a clear and full concept of the veterinarian's responsibility in public health should be imparted to the student.

Without any attempt to list an order of priority, which will be set by the different schools according to their needs and possibilities, some of the important subjects that warrant inclusion in the study plans and programs can be listed as follows:

Statistical methods; food hygiene and control, including principles of technology; epidemiological methods and epidemiology of zoonoses; public health administration and practice; behavioral sciences (social sciences, cultural anthropology, techniques of health education); environmental health; human and animal nutrition; introduction to research in comparative medicine; contribution of the veterinarian in "space" medicine, natural and war disasters, and radiobiology; laboratory animal medicine; production and control of biological products.

Faculty members should make every effort to keep up to date, through intensive short courses, their knowledge of these subjects and of their application to health.

TOPIC I

Public Health in General

VETERINARY MEDICINE AND PUBLIC HEALTH

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It is not known with any certainty, and perhaps it will never be known, how and when man first began to take steps for the care and promotion of his health. It is possible that this took place from the time that the human race reached the stage of recognizable individuality. Documents of the most ancient cultures usually contain some references regarding the efforts of man in bygone ages to avoid illnesses and improve his health and welfare. At first there were only prayers or petitions to supernatural beings in whose existence primitive man believed and to whom he attributed the power of giving health or of causing disease. Such beliefs were drawn together in religious thought and attitude, and as a result, recourse was had to prayers, to propitiating sacrifices, and to various ritual practices carried out directly or through the intervention of priests.

In Greece, in the fifth century B.C., the first ideas on the natural cause of disease and on health were propounded; such ideas suggested recourse to practices that would modify environmental aspects wherein the principal causes of disease were thought to be based. Empedocles of Agrigente, who changed the course of a river in order to deal with some marshy fevers, and Hippocrates, who caused bonfires to be burned in public places with the idea of purifying the atmosphere as a method of combating a plague epidemic, are concrete examples of rational practices, albeit wrong, of those times, designed to fight against disease and safeguard the health of their fellow men.

Many centuries have gone by since that time and great changes have occurred in thought and deed with regard to health protection. From among the rather magic practices and ideas of the past, traces of which still persist in the primitive cultures of some communities, other ideas were slowly being brought forth, in the light of new knowledge obtained through observation and study, which even included a rudimentary form of experimentation and which inspired priests, savants, philosophers, and of course, the physicians of that time.

The seventeenth century had hardly dawned when the beginnings of a coherent system of accumulated knowledge concerning the prevention of disease and the promotion of health were drawn up. The results obtained by the application of such inspired measures were heartening, and served to encourage new studies and to enrich medical experience.

Toward the end of the eighteenth century, social medicine was born, and this revealed the especially worthy idea that medicine is not only a purely biological discipline, but also a social science because of the importance it has for the well-being and progress of communities. A great step forward in preventive medicine was made a few years later, when the Industrial Revolution highlighted the importance that certain economic aspects had to the health of people, and forced the adoption of measures to protect the health and lives of manual laborers. Some little time later, the discoveries of Pasteur and the work of Koch and others firmly established the parasitic origin of communic-

able diseases and revealed how these could be transmitted, thus giving to mankind a firm and scientific foundation for developing the health sciences, which are the inspiration and guide for public health.

At that time, it was becoming clear that the knowledge and training generally given to those who were preparing to become physicians was not enough, in itself, to equip them sufficiently well to carry out their work in health. The necessity for specialization in medicine was thus recognized and, among other specialities, that of preventive medicine was developed.

As the need for the special preparation of physicians who were to become health workers became apparent, it was also realized that the assistance of experts in other branches of knowledge would be required. Nurses, dentists, microbiologists, chemists, engineers, mathematicians, geographers, and anthropologists were called upon to lend their knowledge and skill in support of the discipline that has as its goal the care of human health. Among those assisting the health worker was included the veterinarian, to whom was assigned the fight against the zoonoses, the diseases of animals transmissible to man, and he was charged with regulatory functions as they referred to foodstuffs of animal origin. Today, on the staff of official health agencies, there are always some posts assigned specifically to veterinarians.

Nonetheless, it would appear that the true quality and the full extent of the relationship that the veterinarian may have with public health authorities has not been fully appreciated. A striking example of this lack is found in the fact that a great many texts related to health and preventive medicine, to health administration and related subjects, hardly mention veterinary medicine. In a few texts treating of the auxiliary disciplines in preventive medicine, the authors present long lists that they do not consider complete, since they end with the words ". . . and others." In such lists, veterinary science is not expressly mentioned; sometimes it is quite forgotten by the author, or perhaps is meant to be included in these "others."

The role commonly assigned to veterinarians in official health agencies tends to be limited to technical-administrative functions of mere routine, concerned principally with exercising control over foodstuffs of animal origin, principally meat, milk, and their derivatives. In more highly developed countries, veterinarians play a part in the inspection of fish, oysters, and other foodstuffs of lesser importance. In addition, of course, they are given some participation in the control of zoonoses.

It would appear wise to think that veterinary medicine should not limit its participation to the purely auxiliary or routine administrative aspect of the health services. Certainly a much greater collaboration at much higher scientific and technical levels would be more advantageous for the fundamental purpose of public health. It would be fitting to speculate, therefore, on what might explain this scanty participation of veterinary medicine in public health, and on this wide separation that exists between physicians and veterinarians.

There is not the least doubt that the responsibility for such a situation falls, in great measure, on the physician. Medicine and veterinary medicine are two formal and distinct disciplines, two different careers, two professions that are frequently not drawn together in practice or in research.

Each discipline is taught in its own school and it is not customary to have any doctors among the professors of the veterinary school, and much less to have veterinarians in a medical school. This fundamental separation induces a certain attitude that would be difficult to define without exposing oneself to the risk of error. The fact is that there is a gulf between physicians and veterinarians; they are strangers, there is indifference, and sometimes even a certain degree of discrimination. The physician is satisfied with being a physician and would be insulted to be mis-

taken for a veterinarian. The competent and well-prepared veterinarian knows perfectly well that he is not inferior to anyone and that his mission is a useful and highly beneficial one for humanity. He knows, moreover, that his profession is based on science, and he does not ignore the fact that to be a good veterinarian requires a basic knowledge of biology much wider than is customary for physicians to have. This last concept is very true; the veterinarian is concerned with different species of animals and he has to know the anatomy, the physiology, the agents that alter health, the pathology, the symptomatology of the diseases and methods of treatment of each species. To do this, he must have a knowledge of basic sciences equal to or even more extensive than that generally given to physicians. Physics and biological chemistry, biology in particular, and other auxiliary disciplines such as mathematics, botany, geography and ecology, as well as other subjects are all indispensable for him. Insofar as experimentation is concerned, the veterinarian has, as a rule, possibilities not available to the medical professions. Veterinarians are able to study morbid conditions in whatever number of individuals they consider necessary, and to observe through biopsy and post-mortem examination whatever phase of these processes they wish in order to ascertain their nature.

These possibilities are more obvious when drug trials are being dealt with, and in this the veterinarian can obtain results of high precision, working with sufficient numbers of test animals and controls to obtain results adequate for statistical analysis. For this reason, veterinary medicine can aspire, in various aspects, to reach a high scientific quality equal or superior to that obtainable in medicine; thus for this and other reasons, there is no cause for veterinarians to feel themselves at all inferior to other professionals.

On the other hand, veterinary medicine is much more than a discipline concerned with the curing and prevention of disease in the animal species that man has domesticated in order to satisfy some of his most urgent necessities.

One of the outstanding achievements in the field of health consists in the clear understanding that the health of man depends not only on the play of recognizable environmental and biological factors, but also that in the human environment there are factors that strongly influence public health in one way or another. Various social, economic, and cultural factors are among the determinants of many pathological conditions or may contribute to the state of complete physical, mental, and social well-being that is health, in the sense defined by the World Health Organization.

In this respect the role played by veterinary medicine has great importance. Thanks to the veterinarian, it has been possible, at least in the most economically advanced countries, to make fullest provision for foodstuffs of animal origin necessary for the life and health of man. One need merely mention the tremendous food value of milk and the well-known consequences of a lack of this food, which entails not only the scarcity of this product, but a situation that induces its adulteration and improper handling and can convert this foodstuff into a vehicle of deadly disease.

Meat, fish, poultry, and their derivatives, all these are riches on which man has been known to place a high value from the earliest times to which the Bible refers. The prominent men referred to in this Book estimated their riches and their position in the social hierarchy according to the number of head of cattle they owned; and when Jehovah announced to the chosen people that he would lead them to the promised land, he praised the land, saying that it was overflowing with milk, the most excellent food, and with honey, symbol of the enjoyment of food.

Three-fourths of the human race are suffering from hunger, which fortunately is

not total in every case, but in almost all instances is a specific hunger for animal protein and a consequence of the scarcity of livestock, fowl, and fish. The purity of food is without doubt very important, as is the purity of water. But much more important is the scarcity of water, similar to the scarcity or lack of foods that yield animal protein. In recent years much has been written, and with good reason, of the deficiency syndrome known in Africa as kwashiorkor. It was soon recognized that this was not an illness of Africa alone, but one that affected all poor peoples in every land, under other labels, sometimes even without a specific name. If the blame for the widespread extent of kwashiorkor lies in the poverty of the people it affects, its absence in other peoples, thanks to an abundant supply of animal protein that furnishes everyone with what they need, is due in large measure to veterinary medicine and to its new branch, zootechnology. Veterinary medicine, in this light, has an important role to play in bringing about certain conditions in man's biological environment that are highly favorable to his health.

At the same time, however, it is obvious that not all the responsibility of mutual misunderstanding and lack of rapport between medicine and veterinary medicine can be laid at the door of health officers or physicians in general. A good deal of the blame can be attached to veterinarians. It is well known that there are many who choose veterinary medicine as a profession, just as many choose medicine, as a decent way of earning a living. This is only human, even if not very noble. While the physician is constantly induced, and sometimes forced, to adopt in his professional life a humanistic attitude—one that is evident even in the meanest and that leads the doctor to sympathize with his patients, to understand something of their troubles, financial and personal as well as medical—the veterinarian, to the contrary, has no occasion to concern himself with such matters. Naturally, the veterinarian often does sympathize with the cases he is attending, but whenever he enters a case he does so at the request of the animal's owner, who knows the price, if not always the value, of the animal and can estimate his possible loss at a precise amount of money. As a result, the veterinarian easily acquires a certain attitude and habits that tend to emphasize the mercenary aspects of his professional services. It is not necessary to dwell on this point, but quite possibly it may provide part of the explanation, and perhaps the justification, for the small degree of appreciation felt for veterinary medicine.

On the other hand, the fact that veterinary medicine is not given greater consideration in the programs of public health services may be due largely to the apparent lack of interest shown in public health by the majority of veterinarians.

The health authorities, knowing that it is necessary to have proper training to become a health officer, a training that above all must instill in whomever receives it a profound interest in community health, call upon the veterinarians only to fill administrative posts involving a minimum of technical work and a maximum of routine.

The situation described, which exists in varying degrees according to the country considered, is one that should not continue. It is essential that the physician understand his veterinary colleague better, that he seek his cooperation and assistance, not merely in a few administrative health posts, but in the planning of activities for raising the level of health of the people. For this collaboration to be fruitful, the veterinarian, too, must do his part to earn the esteem and confidence of the health officer.

What can the veterinarian do to achieve this? There is much he can and should do. Above all, as in the case of physicians, he must change his goal so as to consider, not disease, but health as the essential object of his professional activity. When the clinician thinks more in terms of health than of disease, he is better able to understand psychic

factors as determinants of pathological conditions, the importance of the social character of medicine, and the role played by the health officer in society. He can see more clearly that the ultimate objective of medicine is the preservation and promotion of health, and that the struggle against disease is only a part of that whole function.

The veterinarian should lift his sights and think more in terms of health than of the diseases he is engaged in curing. This is true for the health of animals, and above all, for human health. When the veterinarian examines, treats, or operates on animals, he does so not at the animals' request, nor to please them or ensure their immediate good, but at the request of the animals' owners, to serve those owners and prevent an economic loss they would suffer if the animals died, or to safeguard the owner's assets or future profits by ensuring that the animals are in complete good health. The final objective of veterinary medicine does not lie, therefore, in the animal species that the veterinarian commonly treats. It lies, very definitely, in man, and above all in humanity.

The owner of a herd or a flock is primarily concerned with preserving or increasing the wealth represented by the possession and the reaping of the product of his animals. But he can do this only if the product renders the service that he expects of it. Thus, beyond the owner's private interest lies the greater interest of the population that expects these resources to satisfy its essential needs: food, dress, and personal comforts.

It could be argued that since man after all is the final goal of all human activity, it is not important to stress this concept in the case of veterinary medicine. But it is precisely because this discipline, so scientific and so technical, finds itself constantly before a concrete and immediate objective, that often it is prevented from considering its more distant goals, as happens with those who cannot see the forest for the trees.

When the majority of veterinarians become fully aware of the importance of their mission, much advantage will be gained: a better integration of study plans and programs and of the teaching body in schools of veterinary medicine so as to achieve the highest qualification of the professional veterinarian; a greater appreciation of the different fields of responsibility; a better understanding of the value of different courses; and a better comprehension of the importance of the basic and fundamental disciplines that form scientific criteria without which the veterinarian would be a mere animal curer.

Another important aspect of the close relationship between physicians and veterinarians is concerned with activities in experimental medicine. The research worker in this discipline has to turn to animals for the experiments that will allow him to discover what occurs in man. For this research, the physician must have healthy animals, free from disease, and sometimes even germ-free. Often he needs animals of pure stock, genetically similar, so as to ensure that the results obtained are due solely to the experimental factors introduced in the research process. For this, the help of veterinarians is required, and the latter's role has always been held in high esteem by the great research workers in experimental medicine. Pasteur, when he began to study infectious diseases, keenly felt the need of assistance by a physician and obtained the valued cooperation of Dr. Roux. He also understood the importance of having the assistance of veterinary science, and reached the stage of establishing a special institution at Garches, which now functions as an annex of the Pasteur Institute in Paris and conducts the veterinary aspects of research.

Another concrete example of the value of such collaboration is to be found in the preventive vaccination against tuberculosis, today universally employed and which bears the names of the physician Calmette and the veterinarian Guérin, who together succeeded in establishing the strain of bacillus from which the vaccine is prepared.

The veterinarian must think more and work more in the sense that has been outlined above, that is, with an awareness and a knowledge of man, of the health of man. The health officer attaches great importance to the health education of the public, since preventive medicine can fully achieve its purposes only when its activities are conducted with the active cooperation of the community, which can be obtained only through a well-organized educational program. In this respect, the veterinarian is perhaps in the same position as that occupied by the physician a century ago, when the doctor was called upon only in case of sickness, and many times only in grave illness. To enable the veterinarian to apply fully his knowledge and special skills, those who request his service in case of illness must do so in good time and not only *in extremis;* and to bring his capabilities to bear in the prevention of disease and the promotion of health, a particular type of education should be given to that segment of the population that requires such services. The veterinarian must therefore concern himself with health education, as a means of teaching the value of health and the cost of sickness in animals, of explaining how and why such illnesses occur, and of informing the population of the new possibilities for improving the health of animal species that are of service to man.

To do this, the specific resources of the veterinarian will not be enough, since he now has to deal with men; he must know how they think, how they feel, how they act.

It is therefore evident that the training of today's veterinarian must be modified in such a way as to change that professional's ultimate concern from animal disease to animal health, and through the latter, to the health and well-being of humanity. In all subjects of the curricula, advantage should be taken of every opportunity to instill in the students an attitude conducive to the fulfillment of those purposes. It would also appear necessary that schools which have not yet done so should establish chairs or courses of public health, in order to teach the students the fundamental concepts of public health, the factors that influence it, its importance for the well-being and progress of peoples and nations, and the means to be used to foster and improve it.

Something else should be added to the education of the veterinarian, and that is a better and more complete knowledge of man, not only as an individual of a species, but as a person, and especially as an integral part of society. To be able to properly guide himself in his professional relations with his fellow men, and through them to help achieve the purposes of his profession, the veterinarian needs to know them better from the social, economic, and cultural points of view. Above all, he must clearly understand, with neither confusion nor exaggeration, that in order to win all the respect due his important functions, he must seek to conduct himself as a true man of science, and in his dealings with others must be guided by the highest ethics and principles of rectitude and honor.

It is to be hoped that, with a better preparation, made possible by the greater facilities now available, the students of today, the veterinarians of tomorrow, will acquire a fuller understanding of their position in the communities which they serve, and from which they will obtain, in due compensation, the resources to live decently as professionals.

From this new situation, it is to be hoped that a fuller and more cordial understanding will develop between physicians and veterinarians, in which both may find satisfaction, inspiration, and stimulus, and from which the community may reap greater benefits as the result of the closer ties between two professions that have the same purpose, the same goal, the same ideal: the protection of man's health.

TEACHING THE VETERINARY STUDENT TO FULFILL HIS SOCIAL RESPONSIBILITY

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It is perhaps somewhat childish to ask whether the veterinarian is at the service of animals or of man. However, it would not be difficult to find those who think that he is not at the service of either, but rather serves science or economy. Others will say that, in any case, as is well known, both science and economy are inseparable from man. It is possible, as a result, that the majority think that the veterinarian is at the service of man, controlling animals for his benefit; that his job is to determine the number, quality, state of health, distribution, and use of animals to ensure the best possible ecology and the satisfaction of human interests.

THE TRAINING OF THE VETERINARIAN

If we accept this premise, it will be easy for us to evaluate the education of the veterinarian. Something evident comes to mind then: his training in animal control may be more or less broad, more or less comprehensive, but it has always been and is the essence of his education. On the other hand, although he is at the service of man and society, he is not prepared, at least formally so, to understand man or serve society.

Of course, we must ask ourselves whether this is indispensable or possible. Has he not served humanity well? It cannot be denied that the veterinarian has contributed to the development and welfare of social life. Indeed, his contribution has been important not only in the advancement of biological and medical science, human nutrition and economy, but of public health itself. In fact, among other achievements, he has eradicated animal diseases, some of them communicable to man; he has established patterns and attained goals in the hygienic control of foods; he has participated in the mastering of many techniques indispensable in the prevention of disease; he cooperates through experimental research and comparative medicine to the progress of medicine; and above all, through the epidemiologic method, he has pointed out new roads for advancement. Why, then, should we worry about broadening his education, which is already extraordinarily complex? It would seem, even, that this concern reflects a reproachful attitude that is unfair from any standpoint.

On the other hand, is it possible for the veterinarian to learn the sciences of behavior, education, economy, epidemiology, and administration, aside from the basic sciences and the veterinary medical sciences?

THE VETERINARIAN IS A PROFESSIONAL

It is difficult to imagine one man having command of so many disciplines. When all is said and done, is not the veterinarian a professional? Or is he only a technician? I believe that the concepts that distinguish the technician from the professional are equally applicable to both the physician and the veterinarian. It is generally recognized that the technician is the person who can apply scientific knowledge, and the professional the one who can do not only this but also

evaluate it in order to face the unexpected and the unknown rationally, and, above all, to make use of his ability with a high sense of ethical and social responsibility.

The professional, then, is entirely different not only from the technician but from the scholar. There is not the least doubt as to the fact that the veterinarian need not be a scholar, and that if he is a technician he is so only to the extent that he applies scientific knowledge that he has subjected to critical analysis, with a sense of social responsibility. For this reason, I am convinced that the veterinary student, just as the medical student, should above all be taught to learn by himself and to develop both a scientific attitude and a sense of personal responsibility. Aside from this, of course, he must learn the principles that govern animal life and those that determine its relationship to human life.

Therefore, the veterinarian is not, simultaneously, a technician in a laboratory, a technician in animal breeding, in the prevention or cure of diseases, in food hygiene, in food preservation and processing, etc. In other words, he is not a multi-technician; he is and should be only a professional. But let us frankly recognize that not all veterinarians, as not all physicians, are professionals; many, unfortunately, are technicians with a professional degree. But this could not be otherwise; it would be utopic to expect all students to develop and attain the maturity of a true professional. The problem lies in the fact that many of these technicians (with a professional degree) have received superfluous education, that is to say, education that is unnecessary for the task they perform. On the other hand, although they do obtain the degree, many students do not reach the level of professionalism for lack of adequate training. As a result, we have technicians with useless and soon-forgotten knowledge and professionals, sometimes scholars, without the optimum personality.

Can the problem be solved by multiplying the disciplines that the student must master? Decidedly not. However, if we broaden the scope of teaching in the sciences used in public health, including administrative sciences and the so-called behavioral sciences, will we obtain a larger percentage of genuine professionals? I am convinced that we will. We will, if education is planned to achieve the objectives I have pointed out. After all, learning to learn by oneself and the development of a critical mind as well as a responsible personality are achieved by the student, not through the accumulation of a great deal of knowledge, but through his attending a well-organized school that is adequately integrated into the social structure and where, above all, there is respect for the right to differ from others and where the rejection of dogmatism is encouraged. This can be attained only if the veterinary medicine schools, the veterinary sciences, and the students of veterinary medicine form a part of, study, and participate in the life of the community.

On the other hand, because of the extraordinary complexity of the veterinarian's responsibilities, he will not be able to fulfill his function adequately if he does not work as part of a team. He must be persuaded that his work will be fruitful only if it forms part of a general program within which his personal function is only one of many that are duly planned and coordinated to achieve a common goal. In that way, he will realize that in increasing his knowledge, his efforts, and his individual enthusiasm he will achieve only very precarious results if his endeavors are not accompanied by the development, the efforts, and the enthusiasm of others. More often than might be supposed, the intelligent professional is obliged to use his qualifications to train others, and to set aside his personal development in order to assure some desired achievement.

Moreover, the veterinarian, just as the physician, in order to subsist and develop as a professional, needs to live—that is, participate, motivate, and be motivated—in the professional world of health. Through the

example of their own organization, schools should teach that the professional who becomes isolated from his group and from social life soon deteriorates, in personality and in professional quality.

SOCIETY AND THE VETERINARIAN

If the veterinarian is at the service of man, if the development of his professional personality is possible only through his forming part, in an organized manner, of the professional world of health, and lastly, if he can be conscious of his responsibility only through his participation in the life of the community, then I believe that the study of social sciences and health is not only advisable but indispensable for him.

What is more, we cannot and should not forget that the animal world that is traditionally under the care of the veterinarian is conditioned by society. It is obvious that whether in the future there will be 10 cows per person or 10 persons per cow will depend on the decision of man, not of the animals. Whether the cows are healthy, well-nourished, and good milk producers will depend on the communities. The role that animals play at present and will play in the future depends on human culture. In the past, they once served as gods, laborers, offensive and defensive weapons; now, in the more advanced cultures, man uses them almost exclusively as a food source, as means of recreation, and as means for satisfying his unquenchable thirst for knowledge.

The veterinarian should condition his professional conduct to the demands of society, which he will not be able to interpret accurately if he has not learned to understand them.

Also, scientific and technological progress, in modifying social life and its environment, alters animal life and creates the veterinarian's responsibility to protect both animal life and man.

The veterinarian is primarily concerned with groups of animals rather than with individuals. Contrary to what happens in the case of the physician, he kills and can sacrifice the individual to protect the group. His clinic is much more epidemiological; for him, the ecological factors are of greatest value.

But his role is not limited to interpreting the social needs and establishing measures of control for animals and their products. This would greatly limit his efficiency. He must obtain the collaboration of society. This means that he needs to know the factors that determine human behavior if he expects his decisions to be effective; his knowledge is sterile if it is not understood and supported by society. What is more, his qualifications as a professional will be overlooked if he does not know how to "sell them," as is said nowadays, to the communities. The number of veterinarians is not determined by the number and the needs of animals, but by the social demands, which are sometimes altogether foreign to those needs. Regardless of the fact that the veterinarians almost always obtain substantial financial compensation for their work, the place where that work could be more effective is often where it is less used, owing to ignorance regarding its objectives. All this means that the veterinarian needs to improve his ability as an educator.

Finally, it would be advisable to insist that the task of the veterinarian be closely related to economy and administration. So far, however, he has not been motivated to study these important subjects.

THE TEACHING PROBLEM

If we accept, even temporarily, that there is a need for the veterinarian to be educated in public health and the social sciences, we shall still have to cope with the problem of how and what to teach. Whatever the procedure adopted, the number of disciplines with which the student should be familiar is clearly excessive. Will we not make the

mistake of making him, as the saying goes, "Jack of all trades and master of none"? Will we not make him a professional of generalities, uninterested in and not qualified for specialities? Or, perhaps, will we oblige the majority to soon become specialists and, as a result, end up without veterinarians? Or, what is worse, will we not awaken in the majority of students a disproportionate interest in man that will cause them to disregard the problems of animals or view them with disdain? I believe that all this is threateningly possible and demands the establishment of an adequate policy to prevent its happening.

THE CURRICULUM

Should it be a policy? Could it not be several policies? For example, as science develops, the number of technicians multiplies. Has this phenomenon occurred in the field of veterinary medicine? Is it advisable to give greater preference to the education of technicians working under the direction of professional veterinarians? What advantages and what disadvantages could be offered by food hygiene technicians, laboratory technicians, technicians in the rearing of certain animal breeds, and technicians in the application of preventive measures? Does routine activity in any of these fields require a professional?

It seems to me that in countries with limited resources it is advisable to promote the education of various technicians, always in proportion to the number of professionals available and in accordance with the priorities and the needs determined by ecological, economic, and social conditions. In the final analysis, would it not be highly advantageous to avoid obliging many technicians to study all subjects at a professional level, and many professionals to act as technicians because these latter are scarce? With a sufficient number of properly trained technicians, it would be easier to plan a better education of the professionals.

From another point of view, it would be worth while to consider the possibilities of an education of the professional aimed at qualifying him better for the activities having greater demand and standing. In Mexico, for example, the veterinarian would require special training in the breeding of animals, which is of utmost economic importance to the country, in education and organization, and in the control of the more prevalent zoonoses. In other countries, special emphasis should perhaps be given to his education in biology, in scientific research, in food technology and processing, and so forth. But whatever the curriculum, it should always be planned so as to achieve in the student the development of a truly professional personality, which will ensure his adaptation to the prevailing needs.

The basic sciences, veterinary medicine, and public health can and should be used, fundamentally, to achieve the objectives of professional education. Statistics, for example, should be taught according to the role it is to play in developing the student's personality. Does it contribute to his development of a scientific approach? How extensive and how deep a study of this subject is required to achieve this end? The sciences of human behavior often help stimulate the development of social responsibility if they are associated with proper organization of the life of the student and of the faculty. Physiology and the biological sciences promote the formation of a conscientious attitude and intellectual honesty.

Of course, the teaching methods should also harmonize with the achievement of the general objective. Initiative and self-confidence are indispensable for learning to learn by oneself. The support and stimulus of group activity, respect for the opinions of others, and reasoned criticism promote the student's creative capacity. His living and working together with others, his social par-

ticipation, his identification with the hopes and frustrations, successes and failures of the community in its pursuit of established goals, all teach him to respect and have appreciation for the efforts and limitations of man and allow him, at the same time, to learn how to identify attitudes and ideals. For example, the successful breeding of healthy and economically productive animals should be viewed by the student not only as a result of his professional participation in this activity, but also as the outcome of his participation in group behavior oriented through experimental programs organized for educational purposes.

Actually, the problem of education does not lie essentially in the quantity of disciplines that should be taught, but in the large number of them that the faculty wants to include in the curriculum. It lies, in fact, in the voluntary or involuntary lack of knowledge of the educational objective. This objective is not to give more and more information, but to motivate. The school only indoctrinates; practice, or experience, qualifies the individual; for this reason, the new graduate should be considered only as potentially qualified or capable. As a result, it is imperative, as in any other profession, to establish postgraduate systems that will gradually and promptly increase the professional's responsibilities. This is done by offering him a well-organized institutional environment, with established levels of authority, wherein he finds encouragement, protection, support to his own initiative, understanding, and possibilities for identification with the group.

In the final analysis, the difference between a technician and a specialist, or a scientist, lies in the intellectual and social personality of the latter. After receiving his degree, the veterinarian soon finds himself unable to cultivate a particular branch of his profession, owing to the great number and heterogeneous nature of his functions. If he completes his studies without having developed the proper personality, the personality of a professional, he will become a technician instead of a specialist or a scientist. That is why, also, when he lacks this personality, he seeks shelter in a special branch of technology because he feels useless. On the other hand, if he has a professional personality it makes no difference whether he acts as a general practitioner, a scientist, or a specialist; in all circumstances he will be, first and last, a professional who is fully aware of his scientific responsibility and social mission.

It is for this reason that the social mission of the veterinarian, which is mainly related to protection of human health, increase of livestock production and economic development, promotion of education and well-being, and finally, to scientific progress, cannot be fulfilled through the increase of his knowledge, but depends on the improvement of his personality. The objective is not that he should master all sciences, specialties, subspecialties, and techniques covered by his profession; the aim is that he understand his mission, that he learn to love his work, that his scientific approach enable him to fight for the truth and protect it against dogmatism, routine, and fear of the unexpected; that his respect of man lead him to seek to know and to work with his fellow men; that his professional doctrine identify him with all who work toward human welfare; and finally, that he develop self-confidence so that he may be constantly educating himself and not remain behind scientific progress and social evolution, but accept responsibility for promoting them.

It is not possible to make men of this mettle out of students trained only in the world of science and technology; pure science is interested in truth but does not pursue humanitarian objectives. In public health, which is a science but at the same time an art, the student will find not only firm support and guidance for his complex task but also the creative inspiration that is necessary for his constant betterment.

I am thoroughly convinced that the social

role of the veterinarian, in all its enormous importance, can be fulfilled if the veterinarian is a professional by training and, by vocation, a humanist. As a professional, he must have the ability to apply scientific knowledge and the criteria for subjecting it to critical analysis, doing both with the highest sense of ethical responsibility. As a humanist, he should strive not only to enhance the dignity of man, but to pass on to future professionals the highest values of his own generation.

ROLE OF THE VETERINARIAN IN THE SOCIOECONOMIC NUTRITIONAL WELFARE OF THE COMMUNITY

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In a recent address to the American Veterinary Medicine Association centennial observation, in which the contributions of veterinary medicine were discussed, the Surgeon General of the U. S. Public Health Service[1] reviewed a century's progress in public health. It is less than 100 years ago that veterinary medicine became cognizant of its socioeconomic responsibilities in the Americas, although some European veterinarians and physicians were describing the problems as early as the eighteenth century. The cattle plagues (rinderpest) of that century were among the most devastating experiences ever encountered by man, and they seriously affected Europe's social and economic structure. Wealthy landowners found their income drastically reduced, merchants were deprived of products of animal origin for trade and consumption, peasants were depleted of animals for production or draught, and urban consumers could obtain food, clothing, and leather goods only at exorbitant prices. The plague was of such great concern that Pope Clement XI had his physician, Giovanni Lancisi, investigate the epizootic when it first appeared in Italy in 1713 and reported on the disease itself and its social consequences to the College of Cardinals. Lancisi's recommendations were sound. He urged the establishment of quarantine, the inspection of meat, the destruction of sick animals, and the hygienic control of the environment. Perceiving the hardship that these restrictions would place upon the peasants and landowners, he also urged that these people be exempted from taxes during the epizootic.[2]

The control procedures prescribed by Lancisi soon rid Rome and its surrounding countryside of the plague, but the remainder of Italy and Europe suffered devastating losses before they came to accept state control. Smithcors[3] estimates that between 1711 and 1769 over 200,000,000 cattle died of plague in Europe, and that an even greater number were afflicted. The direct effect upon farmer and peasant, livestock dealer and trader, merchants and butchers, tax collectors and government, political and military decisions, and the social and religious mores of that period are incalculable. The enormity of this loss may be appreciated if applied to present-day cattle populations. In the United States this would correspond to a loss of about 20 per cent of the dairy cattle, or in terms of 1950 values, an annual loss of one and one-half billion dollars. If applied to the beef cattle industry the loss would be even more staggering. Another way to

[1] Terry, Luther L.: "A Century's Progress in Public Health." *J Amer Vet Med Ass* 142: 1287-1291, 1963.

[2] The English Government actually paid an indemnity to owners of diseased cattle when the disease first appeared in 1714. This appears to be the first instance of government indemnity for disease control.

[3] Smithcors, J. F.: *Evolution of the Veterinary Art.* Veterinary Medicine Publishing Co., Kansas City, Mo., 1957, 235 p.

picture the effect would be to imagine a 20 per cent capital tax on all animals. Understandably, the far-reaching consequences of the cattle plagues helped to instigate the social unrest that followed in the late eighteenth century.

The devastation caused by rinderpest was so great in France that nearly half the cattle population was destroyed between 1710 and 1714. The Government established a commission of physicians and agriculturists to determine what action was needed. After 40 years of reports, petitions, bickering, enormous economic losses, and subsequent social disturbances, a royal decree of the French council of state empowered Claude Bourgelat, a veterinary physician who was an eminent author and authority on animal diseases, to establish a school at Lyon for the study of the diseases of cattle, horses, and other domestic animals. Cattle were to be given priority in these studies because of the epizootics that had plagued the country for decades. The school was opened in 1762 and immediately gained fame for its advice on handling disease outbreaks. Students from all over France and Europe came to Lyon to study. These students in turn became the faculty of new schools that were established at Alfort (1765), Vienna, Berlin, Hanover, Munich, Copenhagen, and eventually in all the countries of Europe. The dissemination of sound disease control measures, the quarantine of sick animals and the restriction of their caretakers, the destruction of diseased animals and vectors, cleaning of cow barns and sheds, disuse of fields and pastures where sick animals had grazed, all had their effect. The cyclic nature of rinderpest is no more understood than that of other plagues, but the epidemiological principle that epidemics or epizootics can be maintained only by large numbers of susceptibles is certain. Whether or not the rinderpest epizootic cycle was naturally on the rise or decline, the establishment of disease control measures and their successful enforcement in France stopped the disease and gave respectability and prestige to the new schools and their graduates.

Here was the beginning of the measurable contributions of veterinary medicine to a society that was changing from rural to urban under the impact of the industrial revolution. Without some semblances of animal disease control, this transition could have been delayed or postponed for decades—holding back the greatest advance of man since the dawn of history. The successful application of animal disease control measures in Europe during the late eighteenth century allowed the industrial revolution to maintain its pace into the nineteenth century and beyond. The availability of animal products such as meat, milk, fiber, hides, bones, horns, and hooves continue to this day to provide sustenance for both man and machines.

The nineteenth century opened with veterinary medicine and education firmly established in Europe. The ability to control animal plagues had been demonstrated, although the periodic waves of foot-and-mouth disease had not yet appeared as epizootics. Meat inspection was widely practiced although it was in a transitional period. During the seventeenth century, the role of meat inspection changed from an attempt to control syphilis to the more rational concept of preventing animal-borne disease and food poisoning. As the industrial revolution of Europe gained momentum, people concentrated in urban areas and public health problems were compounded. Fortunately, Jenner, a physician who was an outstanding investigator of veterinary problems, had demonstrated the efficacy of vaccinia immunization, which became the basis of public health practice in many countries.

But other diseases affected the health of the public to such an extent that governments and businessmen became concerned. Tuberculosis spread so rapidly in some countries that it had all the characteristics of an acute epidemic disease; it also appeared among milch cows in Europe and was even-

tually carried to the Americas in purebred stock. In areas with concentrated populations, summer colics of children and epidemics of scarlet fever and streptococcus sore throat were traced to dirty milk. Diphtheria and typhoid were also on the rise; their incidence crested toward the end of the nineteenth century. The scientific confirmation that many tapeworms originated in cattle and swine, and that pork was the vehicle of trichina provided a sound basis for veterinary public health practices that are in effect today. Development of epidemiology led to the conclusion that milk was one of the most important vehicles of disease-causing organisms. This discovery provided veterinary medicine with an even greater challenge than that of meat hygiene. Although these problems were partially resolved—at least academically—in the nineteenth century, solutions were slow to be adopted. Even today we look with amazement on the perpetuation of these problems in many areas.

The public health problems of the nineteenth century brought the physician and the veterinarian together. Veterinarians in Europe and North America began to report their findings, and to promulgate regulations to protect the health of the public. The meat and milk codes of that period are well known and will be discussed by other speakers. Of even greater interest are the basic discoveries of veterinarians in the fields of bacteriology, pathology, immunology, virology, and parasitology. These were to provide a foundation for preventive medical practices in both public and animal health. Pasteur and his veterinary associates gave an enormous boost to furthering man's well-being throughout the world. Many of the first health departments in the Americas were established as Pasteur laboratories for the production of antirabies vaccine. Likewise, Pasteur's development of veterinary biologics made possible an expanding animal population throughout the world. Smith and Cooper's demonstration that Texas fever was transmitted by ticks gave important support to those who believed that yellow fever and malaria were insect-transmitted diseases. Without those advances in science, the social advancements of the late nineteenth and early twentieth century would have been delayed. Those discoveries also became the basis of organized public health practice.

Frank S. Billings, a Boston veterinary physician, pointed out as early as 1884[4] that social progress was dependent upon scientific progress. Dr. Billings made a strong plea for the establishment of a veterinary division in the then National Board of Health. Although this plan was not adopted nationally, it was put into effect in many local communities where veterinarians became members of local boards of health and initiated programs for milk and meat hygiene inspection.

Not only public health but also mankind's economic and social well-being have benefited from the advancement of veterinary medicine. The protection of animal health resulted in an expanded rural economy that in turn provided a base for the industrial revolution. As that revolution proceeded, the demand for animal products including meat increased, leading to the development and expansion of animal industries throughout the world. The economic development of many countries was stimulated by the growing world market for meat and meat products, milk and milk products, hides and hair, horns and hooves, and later, glands for the manufacture of life-saving drugs, i.e., insulin, thyroxin, pituitary extracts, and ACTH.

At the beginning of the twentieth century national programs of preventive veterinary medicine were established in many countries. Research inevitably expanded to support these programs, for they could not succeed without nationally supported research programs. Because conditions vary from country to country, studies must be undertaken to

[4] Billings, Frank S.: *The Relation of Animal Diseases to the Public Health.* Appleton Co., New York, N.Y., 1884, 446 p.

determine how to deal with local problems. The impact of veterinary research through the years has been startling. It has opened vast areas of continents to animal husbandry, given a base to many industries, and improved human nutrition beyond expectation. Probably in no creative area has an investment returned so great a dividend for mankind. An attempt to project livestock losses of the eighteenth century, as described earlier, to our present-world animal population[5] staggers the imagination.

Animals are the oldest and most basic form of capital—a form of surplus wealth that can be used to develop new industry. This type of economy still exists, especially in the underdeveloped areas of the world. These areas probably need veterinary services more than any other today.

It has been estimated that the present world population is about 3 billion people. Estimates place the domestic animal population at about one animal and one fowl for every individual. This ratio hardly provides sufficient sustenance for each child, woman, or man, especially if these figures are compared on a per-annum basis. But the problem becomes more staggering or frightening when one hears that the human population will double by the end of the century. Can we double or triple or quadruple our livestock in the same period? This is the great social-economic challenge that veterinary medicine and animal scientists face. I believe that it can be done, but disease control will be basic to the success of such a venture.

The control of avian diseases has had a far-reaching effect in the Western World. Today, chicken and turkey meat are among the cheapest, most nutritious animal protein available. There is hardly a country in the world that cannot have the benefits of advanced technology in this area. Europe is expanding its poultry production, as are Russia and many of its satellites. Africa and Asia are looking forward to applying the new production techniques. North America should not have any problem in increasing poultry production 5- to 10-fold in the decades ahead. It is possible that by the turn of the century the world will be producing white meat at a rate never imagined—possibly 50 to 100 billion birds annually. That would mean possibly 10 to 20 birds per person annually—a level of production that was attained in North America only a few years ago. The technology is available, space is at hand, and the feeds can be produced in quantity.

Cattle are increasing throughout the world, although the number of milch cows is declining because of increased efficiency (fewer cows are needed for milk production because of greater yield per animal). The cattle population today is close to one billion and is growing at a rate of 5 to 10 per cent a year, and hence should double within the next two decades or less. This can be good, but it can also prove disastrous where land is overused. In the Americas, the cattle-carrying capacity can be doubled and possibly tripled with improved land management and feeding practices. The possibilities of increasing the numbers of cattle in Europe and Russia are excellent, although these areas must first solve their problem of feed grain. Africa is a paradox. It possesses vast grazing land areas, but at present the technology of animal science and veterinary medicine is hardly known except in South Africa and a few other locales. Asia has an enormous cattle population—India alone has over 200,000,000—but only 25 to 35 per cent of these are economically profitable units; most of the cattle population are strays subsisting on whatever they find in their daily wanderings. To convert this animal population into a positive factor in Indian economy involves not only the usual technical issues, but also political and religious mores. China has a vast area that could be used for cattle production; unfortunately, this is not compatible

[5] Steele, James H.: *Animal Disease and Human Health*. Basic Study No. 3, Freedom from Hunger Campaign, United Nations Food and Agriculture Organization, Rome, Italy, 1962. 50 p.

with Chinese social structure or mores. In summary, the cattle population will continue to grow along with the human population and may even exceed that of man. Milk production will probably continue to increase at a faster pace, and therefore, there is no reason why the milk requirements of the human race cannot be fulfilled, as well as the desire for good nutritious beef. A world cattle population of 2 billion animals or more is not improbable by 2000 A.D. But, again, the control of disease will be paramount to both human and animal health and welfare.

Sheep are reported to be the world's most numerous livestock, exceeding even cattle. There are about 967,000,000 head of sheep, constituting 33 per cent of the world's domestic animal population. Numbers of sheep have increased throughout the world except in North America, where competition with beef cattle has resulted in a sizeable decrease in the past decade. Mutton is preferred by many people of Africa and Asia, hence it is logical to expand the sheep population in these areas. Expansion is underway in some countries and should prevail throughout the world, except in North America and in some areas where brucellosis is a major sheep disease. A sheep population of 2 billion by the end of the century would not be an impossible goal, especially if goats are reduced and replaced by sheep.

The goat population of the world is about 340,000,000 head (12 per cent of the total animal population). These are mainly raised on marginal lands of Asia and Africa, although there are sizeable numbers in Latin America and southern Europe. It is doubtful that they will increase, in view of their destructiveness to vegetation. Many land management specialists believe that they are undesirable because they speed up soil erosion, although they possibly are the only animals that can survive in some areas. In summary, one can say that goats will not add to future food supplies and may be replaced in some areas by sheep and cattle.

The production of swine and pork products has a high priority in most areas of the world. The United Nations Food and Agriculture Organization (FAO) lists the world's swine population at 485,000,000, although the annual production may be as high as 600,000,000. If swine diseases can be controlled and eventually eradicated, hog populations should double and triple in the decades ahead. The eradication of hog cholera, the confinement of African swine fever, the elimination of genetic problems and chronic diseases, the control of bacterial and parasitic diseases, all are essential if pork production is to keep pace with the growing demand. Pork is one of the most nutritious foods and is in demand throughout the world. Europe is already a high-production area; in the future, it can hardly be expected to hold this pace in view of the growing human population. The USSR hopes to double and triple swine population but is limited by disease problems and feed supplies. China was formerly the world's largest pork producer but production has declined because of agricultural management feed deficiencies, and disease problems. Africa cannot be considered as a future swine-producing area until African swine fever and other diseases are eliminated or brought under control. Hence the Americas remain the only area where swine populations can be increased to keep pace with the human population. The Americas now produce about 35 per cent of the pork supplies of the world; in the future they may have to increase this to 50 per cent by doubling or tripling their production. To supply the world demand for pork and animal fat, the swine population should approach that of man, by these approximate ratios: in the United States, 110,000,000 pigs to 195,000,000 persons; in the world, 600,000,000 pigs to 3 billion people. With an anticipated human population of 6 billion by 2000 A.D., the swine population should expand to between 2 and 3 billion to provide somewhere near the food needed. Other animal populations such as buffaloes, camels, horses, mules, and don-

keys will probably continue to decline as they are replaced by machines. Most of these animals have been salvaged for food in the past, either for man or animals, but none except buffaloes were important as a source of human protein.

In this presentation I have not reviewed the public health problem per se, but will return to the report on *A Century's Progress in Public Health,* where Dr. Terry has reviewed the current and future trends of veterinary public health in our service. The challenge in this area is just as great as in animal production and its effect upon man is probably even greater. I have not touched on the recreational aspects of animals and their relation to man, but it is quite obvious that as man's welfare improves his interest in pets and their welfare also increases.

Finally, we have to face the problem of where to train the veterinarians needed for the tasks ahead. Who will finance the schools and research needed? Where will we find the candidates for the intense training needed? These are questions every Government must face and answer in the decades ahead. Naturally, leadership and guidance should come from the veterinary profession. To provide them, veterinarians must raise their sights and look to the problems of our expanding population and its effect on our democratic way of life.

ROLE OF THE VETERINARIAN IN THE PRACTICE OF PUBLIC HEALTH

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The advent of the germ theory of disease marks the time when the veterinarian first became involved in the practice of public health. During those early days, scientific discoveries came as rain from the heavens to aid man in his conquest of disease. It is sometimes difficult to realize that all we know about infectious diseases, their diagnosis, and their control has come to us during the past century. With the discovery of antibiotics, it would appear that infectious diseases and all the scientific work associated with them should disappear from the life of mankind. While it is true that we now hold in our hands the implements for the complete eradication of infectious diseases from animal and human populations, we find that these diseases are still a scourge to man and beast and probably will remain so for years to come.

It was quite natural for veterinary medicine to enter the field of public health when it became known that many diseases of man had their origin in animals, and that animal food products were responsible for many serious epidemics among human beings. So the responsibility of protecting the food supply derived from animals and of preventing the zoonoses fell to the veterinarian. In general, our profession has shouldered this responsibility and has contributed significantly to the improvement of the health of the people. But we could have done much more than we have done. There are too many places in the world where malnutrition is prevalent because suitable animal foods are not available.

It appears that, as educators, our duty to public health is quite clear. First, we must be certain that the young men and women whom we teach have a clear understanding of the complete scope of veterinary medicine in the world today. Second, we must inform them about infectious agents and the diseases they produce. Third, our students must know the techniques by which diseases are diagnosed and by which food supplies are protected. Fourth, a thorough knowledge of epidemiology must be imparted to them. Fifth, the broad organization of public health must be outlined so that the student will be able to understand where he may fit into the organization.

A great deal of time has been spent in conferences such as this one, in relating our great contributions to public health by the conquering of tuberculosis, brucellosis, salmonellosis, glanders, trichinosis, rabies, encephalitis, and so forth, through the whole list of zoonoses. Also, we have always discussed how much human suffering we have prevented by the inspection of meat and by instructing dairymen how to protect milk supplies. As specialists in preventive medicine and sanitation, you understand all these details and it is not necessary to discuss them.

It would be fortunate if a solution could be found for the limitless poverty, malnutrition, and disease found in so many parts of the world. Does the solution lie in education? Yes, I presume it does, but education appears to be a slow procedure; it takes people and money. Education must combat tradi-

tion and superstition as well as poverty and disease.

If veterinary medicine has the knowledge of how to prevent and eradicate infectious diseases among animals and man, it is important that all people know this fact. We must be supplied with funds with which to educate our students. Employment must be made available to our graduates so that all of the things we teach them may be put into practice. It is apparent that education is needed so that the public—all men and women—will understand and support the truly significant role that the veterinarian plays in public health.

A few years ago a report on educational qualifications of public health veterinarians was approved by the Governing Council of the American Public Health Association. As a part of this report, the functions of public health veterinarians were clearly stated. Probably not all veterinarians would satisfactorily complete all these functions because they apply to local, state, national, and international levels. Nevertheless, the wide diversity of functions is apparent. These functions include:

1. Promotion of veterinary public health activities in urban and rural environs to prevent and control those animal diseases that are transmissible to man by direct contact, indirectly through food products, or by insect vectors.

2. Consultative and field assistance in health administration to obtain the maximum professional contribution of veterinarians in the areas of public health relating to veterinary medicine. For example: as a staff function, the veterinarian advises the health officer and other divisions of the health department in the areas where his broad professional training in biology, medicine, and public health can be applied to the planning and development of programs.

3. The epidemiological estimation of public health dangers and problems arising from the diseases of animals.

4. Development and maintenance of animal disease reporting and statistical services for the evaluation of the danger presented by the zoonoses and of the procedures employed for their control and prevention.

5. Participation in the planning, promotion, coordination, and supervision of programs related to the inspection and hygiene of milk, meat, and other foods and the application of biological principles to the production, processing, and distribution of food products.

6. Planning and participation in laboratory and research activities in the field of comparative medicine, including diagnosis, epidemiology, epizootiology, microbiology, production of biological products, and all aspects of comparative pathology.

7. Active participation in the definition of radiation hazards and in the planning and promotion of programs for the prevention or alleviation of radiation hazards as they may affect the interrelationships of human and animal health.

8. Enlisting the cooperative participation of private veterinary medical practitioners in the solution of urban and rural community public health problems. Liaison with the veterinary medical practitioner. Promotion of various programs such as accident prevention, selected animal disease prevention and control programs, milk and meat hygiene, and general health in the community.

9. Active participation, in cooperation with health education personnel, in the planning, promotion, and development of health education programs relating to veterinary public health activities and the public health needs in the community, and participation in the development and enforcement of health laws and regulations.

10. Consultation and liaison with voluntary and official organizations at local, state, and federal levels, as well as enlisting the cooperation of the departments of agriculture and conservation in the prevention and control of animal diseases affecting public health. For example:

(a) Provision of consultative services to the Public Health Service, state and local health officers, and other departments of government, medical and veterinary medical practitioners, animal and food industries, universities, and the general public.

(b) Cooperation with farm and rural organizations for the control of health hazards peculiar to agriculture and in the improvement of rural health.

(c) Consultation and liaison with agriculture and conservation departments in the prevention and control of animal diseases affecting public health.

In any program to influence and benefit public health, both from an investigational viewpoint and by development of feasible solutions, the 10 areas of activity listed require the biological approach, the concept of group or community health, and the use of the principles of comparative medicine, pathology, bacteriology, and physiology. The veterinarian has been taught to approach problems in terms of the herd or the flock, and thus has been trained in the public health and preventive medical concept of considering the group or the community as a unit.

THE RELATIONSHIP OF THE ENVIRONMENT TO HEALTH

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Man has always sought the answer to his ills in his immediate association with his environment. Volumes have been written on this subject as the history of man has unfolded, and more history is being created every day. You will recall that Hippocrates explained disease in man by the effect of the stars, the moon, the winds, the waters, and the seasons. This we know as the miasmatic theory of disease, the noxious exhalations from putrescent organic material. Inasmuch as Hippocrates lived from 460 to 370 B.C., it can easily be understood how correct he was in many of his observations. What he did not know was not explained until the nineteenth century, with the advent of the germ theory of disease. One often wonders what would have happened, how the history of mankind would have been different, if Hippocrates had discovered that germs were floating around in the winds.

There is little doubt that man's environment plays a very important part in his daily health. Dr. Jacques M. May, Director of the Department of Medical Geography of the American Geographical Society, expressed it thus: "It is known that once an individual is thrown into life with his genetic establishment, he begins to be the target of the stimuli from the environment which model him in shape. The geneticists call this shape of the genotype the 'phenotype.' One can with the pressure of the fingers transform a pellet of clay into a dog, a ring, a dancer, but it will always be the same pellet of clay; so the genotype will be the same but will look different through the pressure of the environment. From the moment a living thing is thrown into an environment, he begins to acquire the scars which, in comparison with the pellet of clay, are the pressure of the artist's fingers. The personality of a living thing at a given time is the sum total of the scars it has acquired since it was first created."

In the study of epidemiology we refer to a combination of things that must be present in order for an epidemic to occur. These are: What? Where? When? and Why? In other words, we are concerned with the cause, the environment, the season of the year, and the circumstances that brought them together. So no study of disease would be complete without the consideration of the environment.

Dr. Thomas Francis, Chairman of the Department of Epidemiology, School of Public Health of the University of Michigan, is recognized as one of the most outstanding present-day epidemiologists. One definition of epidemiology that he gives is: "the study of disease in its natural habitat." He has conceived what is termed an epidermosis—the ecological relationships that lead to causation of a particular disease. The epidemiological community is composed of *environmental factors*, which are social, physical, and biological; *population factors* are inherent characteristics and acquired characteristics; *agent factors* are living, non-living, and negative.

Any disease, whether infectious or non-

infectious, shows the influence of environment. It is obvious that mineral poisons and mineral deficiencies are closely environmental. Weed allergies, in fact all allergies, are environmental. Most parasitism is also environmental, especially those parasitisms that are governed by environmental influences in the completion of their life cycle. Bacteria appear to be affected by the environment. Anthrax bacilli, for example, are thought to persist in more alkaline soils. *Actinomyces bovis* is found at high altitudes in the absence of putrefaction. In fact, practically all of the infectious diseases can be shown to be affected if one would stretch his imagination far enough. Those diseases produced by viruses must have an immediate host on which to live, so they cannot be considered to be affected by the environment. Social customs are induced by the environment. Mental disease, in fact all stress, may be considered to be environmental.

In our modern world of radiation investigation and of space research, one would have a difficult time in describing the limit of his environment in order to be able to determine all of the factors that are environmental and to assess the force of their impact on his well-being.

TOPIC II

Epidemiology and Control of Disease

THE LATIN AMERICAN VETERINARIAN IN PRIVATE PRACTICE, AND HIS ROLE IN PUBLIC HEALTH

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The application of veterinary medical knowledge and practice for the betterment of man's health is now widely known as *veterinary public health.* At the same time, it is clear that the utilization of veterinary medical understanding and procedures for the prevention of illness in man is *veterinary preventive medicine.*

However, this latter term is sometimes confused with *preventive veterinary medicine,* which is that broad area of veterinary medicine, per se, which may be defined as the science and art of preventing disease in animals, whether applied to herds, flocks, pens, or single animals.

Veterinary preventive medicine applies to human health; *preventive veterinary medicine* applies to animal health.

The veterinarian in private practice must, of necessity, have the health of the animal as his first concern because that is usually the purpose for which he is consulted; but at the same time he must keep in mind that human health is closely related to animal health, and he must take action accordingly.

In Latin America, the percentage of veterinarians engaged in private practice is quite small when compared to some other parts of the world. However, almost all Latin American countries have at least a few private practitioners—either full-time or part-time—and it seems probable that more graduates in the future will elect to practice their profession on a private basis. Thus, it is all the more important that these future private practitioners be taught their possibilities and responsibilities for participating in the improvement and maintenance of the health of the people.

The private practicing veterinarian must be familiar with preventive veterinary medicine. He must know that it is necessary to go beyond the sick animal and concern himself with the circumstances under which the animal disease is likely to develop. He is then in a position to take action to prevent the recurrence of that disease.

The private practitioner often takes measures that apply simultaneously to the prevention of disease in animals and the prevention of disease in man. For example, the vaccination of a dog against rabies protects the animal against the disease (preventive veterinary medicine) and at the same time protects people from contracting rabies from that dog (veterinary preventive medicine).

There are a number of ways in which private veterinary practitioners may make direct and important contributions to public health. One of these is the education of the owner or attendant on how a certain animal disease may affect his own health or the health of his family and neighbors. The veterinarian, who is called to attend the sick animal, is in the best possible position to explain these public health ramifications to those responsible for the animal. Moreover, he will be able to advise owners and attendants of any human health hazard that could result from the treatment of a sick animal, e.g., the indiscriminate use of antibiotics for bovine mastitis.

Another very important responsibility of the veterinarian in private practice to public

health lies in the field of disease reporting. Diagnosis is the basis for disease notification, and the private practitioner is usually the first to see and recognize a disease in animals that is transmissible to man. The case may be one of canine rabies, bovine brucellosis, swine anthrax, tuberculosis in a pet monkey, or any one of a long list of diseases that are now recognized as zoonoses. Veterinarians must be fully aware that it is their ethical responsibility—and in most places, a legal requirement—to report the occurrence (or suspicion of occurrence) of any animal disease transmissible to man, whether that disease be exotic or common. Usually, such reports must be made to the local health department or livestock sanitary official, although this varies from place to place.

In his practice, the veterinarian is called upon to carry out testing and/or immunization of animals for a variety of diseases communicable to man—tuberculosis, brucellosis, anthrax, leptospirosis, and rabies, to name a few. He will also treat, with appropriate chemotherapeutic drugs, infectious diseases that are zoonoses, an example being the treatment of dogs for elimination of *Echinococcus granulosus*. Services such as these, even though performed in a private manner on a fee basis, are of course beneficial in the reduction of public health hazards and are to be encouraged.

The practitioner may also be called upon to give advice to clients on the suitability for human consumption of foods of animal origin, such as the examination of a swine carcass for trichinosis.

Still another way in which the private practitioner may contribute to public health is by participating in community health programs. For example, he may be called upon by health authorities to assist in an organized program of mass vaccination of dogs against rabies.

The veterinarian should take an active interest in community health. He should become a member of local health boards; he should assist in preparing local animal health and food hygiene ordinances; and he should volunteer his services for other civic programs for the promotion of the health of the community.

Although these comments are made with reference to the veterinarian in private practice, they apply also to veterinarians in various other fields of activity. In fact, they are applicable, in greater or lesser degree, to all members of the profession.

TEACHING AND RESEARCH IN EPIDEMIOLOGY

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In 1924, Wade Hampton Frost was appointed the first professor of epidemiology at the Johns Hopkins University. That appointment constituted official recognition by the human medicine profession of the necessity for a separate discipline concerned with the study of disease in populations. It was the result of an appreciation, by medical educators and researchers, of the fact that epidemiology was not simply an art, but the science of observation and analysis of mass medical phenomena. In 1963, 39 years later, the University of Pennsylvania School of Veterinary Medicine established a section of epidemiology. This action was the result of an awareness, on the part of veterinary educators, of the contribution that epidemiologists could make to their teaching and research programs. It is the purpose of this paper to present some of the thoughts and experiences that have gone into the development of an epidemiology program at the University of Pennsylvania.

It would be best, at the outset, to clarify what I mean by epidemiology. A working definition can be stated as follows: "Epidemiology is the scientific study of the factors involved in the occurrence and distribution of a medical condition in a population."

There are several key phrases in this definition; first of all, "the scientific study." Epidemiology is a science. Like all other sciences, it has an artistic component that separates the excellent practitioner from the mediocre, and like all other medical sciences, it is founded on scientific methods and procedures. Epidemiology is an applied science that relies on various other disciplines to establish its facts; i.e., biostatistics, microbiology, ecology, and others. The epidemiologist must be prepared to use all disciplines to break down his problem into its various components, to resynthesize these components into an over-all explanation, and to offer a program of action.

The second key phrase in the definition deals with the "factors involved in the occurrence and distribution." This encompasses *all* of the factors relating to the host and its interaction with the environment; that is, the biological, physical, social, and host factors. It is not enough for the epidemiologist to know that *Bacillus anthracis* causes anthrax. He wants to know something about the conditions under which the bacillus manages to survive in nature, the factors involved in the method of exposure, and the response of the host to infection. In a word, the epidemiologist employs the holistic or total view toward medical problems.

I have used the term "medical condition" in my definition because we can discuss the epidemiology of health as well as of disease, both noninfectious and infectious disease; of chronic problems as well as acute. "Medical condition" is a more inclusive term and frees the epidemiologist from the former confines of studying only epidemics.

The last point of the definition is that we are concerned with populations: the herd, the flock, the pack, the community. If we study the individual, it is only as it relates to the group experience. We recognize that populations are not simply aggregates of individuals, but have group properties of their own. These

properties can be characterized at any point or over any period of time.

The purposes of epidemiology have been defined as follows:

a. To define the extent of the problem.
b. To search for the factors of causation and distribution.
c. To suggest a control based on a cause.
d. To evaluate the effectiveness of control.

With the above definition and purposes as our guide, we have developed the following teaching and research programs.

TEACHING PROGRAMS

Undergraduate

The primary objectives of teaching epidemiology to undergraduate students are:

1. To bring into focus, in a single place in the curriculum, all of the principles and concepts of group medicine.
2. To present specific methods for dealing with these concepts.
3. To develop an appreciation for the importance of medical statistics and the proper use of these data.

In order to carry out these objectives, it was deemed necessary to establish a separate course in epidemiologic methods within the Department of Applied Veterinary Medical Sciences.

Before it was given a separate status, epidemiology was included as part of a course in veterinary public health. This was not a sound policy, since it suggested that the only application for epidemiologic methods was in the field of the zoonoses. Epidemiology's concern with the health of populations makes it an essential component of *all forms* of veterinary medical practice, and it consequently deserves an independent place in the curriculum.

The best place for such a course was judged to be the second semester of the junior year. By that time, the students had completed all fundamental courses, including elementary biostatistics, and were in the process of applying that information to clinical medicine. The last part of the junior year was found to be an ideal time to indoctrinate the students in the importance and use of medical records prior to their entry into the clinics.

The scope of the course included a discussion of the purpose of epidemiology, a description of the three fundamental methods of epidemiology (descriptive, analytical, and experimental), medical ecology and the holistic view, vital statistics, simple biostatistical tests and procedures, methods of assembling and presenting epidemiologic data, sampling procedures, application to acute and chronic disease problems, and a discussion of control measures. Laboratory sessions were held in biostatistics, data presentation, and epidemiologic problem-solving. Concurrently, two other courses were offered that dealt with the epidemiology of the zoonoses. An effort was made within the epidemiology course to utilize non-zoonotic diseases as illustrations, wherever possible. A field trip to an Eastern Encephalitis Field Station was carried out to study practical measures in the field.

A total of 15 hours were devoted to lectures (1 per week). Ten additional hours were devoted to laboratory sessions. The material was well received and the teaching objectives met. We have demonstrated to all students the practical value of epidemiology in most fields of veterinary endeavor.

In addition to the specific course, the staff epidemiologist was frequently called upon to give lectures in other veterinary courses on epidemiologic principles, or on the epidemiology of specific diseases.

Graduate

A recent grant by the U.S. Public Health Service has permitted the establishment of a Graduate Training Program in Epidemiology leading to an M.S. or D.Sc. degree.

The objective of the program is to train specialists in epidemiology. They will eventually staff the various veterinary schools, pharmaceutical houses concerned with field trials of vaccines and drugs, governmental agencies concerned with animal disease control, and private veterinary institutions such as the Angell Memorial Hospital and the Animal Medical Center of New York City.

The student must take a course in graduate medicine required for all graduate students of medicine and veterinary medicine in the Graduate School of Medicine. Additional courses in biostatistics, a biological specialty (such as microbiology), and a foreign language will be required. The second year will be spent in preparation of a thesis for the Master's degree, which in all cases will be a field problem with a laboratory phase.

An epidemiology laboratory has been established that will provide facilities for the student's work. The first graduate student will be selected for this fall semester. It is anticipated that when the Graduate Training Program has developed to a point where there are 4-5 students in training, a graduate seminar in epidemiology will be inaugurated.

It must be emphasized that this program is not designed to replace the M.P.H. degree. Those veterinarians who are interested in a career in public health will best fulfill their needs by going to a school of public health. The graduate program is designed for those who are interested in a career in epidemiology in veterinary medicine per se.

Staff

The epidemiology section attempted to influence and educate the faculty as well as the student body in two specific ways. The first involved the organization of a series of staff seminars devoted to the epidemiology of specific diseases. These seminars were given by guest lecturers. The second approach was to offer assistance in the planning, design, and analysis of experiments to staff members. Statistical help was engaged for this purpose. In general, efforts with the staff have been well received.

RESEARCH

In addition to the teaching responsibilities, the epidemiology section is actively engaged in research. The purposes of research are threefold:

1. To satisfy the intellectual appetite of the epidemiology staff.
2. To demonstrate to students and staff the fruits of epidemiologic investigation.
3. To provide a matrix for graduate student research.

I believe that only those actively engaged in epidemiologic research can do an adequate job in teaching this subject. In a newly developing field, it is mandatory that the knowledge of the instructor be based on first-hand experience. It is not enough to advocate the principles of procedure; one must be able to demonstrate to the student that these principles do work when properly applied. Without the opening up of broad avenues of research, the facilities and problems for graduate theses would be minimal.

An important area for epidemiologic research in any veterinary institution involves the case records of its animal clinics. Properly organized and utilized, these records can prove to be a gold mine of epidemiologic information. After months of preparation, we recently inaugurated a new data retrieval system in our small animal clinic. This system, called Termatrex, is produced by the Jonkers Corporation of Gaithersburg, Maryland, and was first described for medical use by Dr. H. M. Carpenter of the Bowman-Gray Medical School.[1] In the near future, we shall describe the application of this retrieval system to veterinary medical problems. We find that Termatrex is inexpensive,

[1] Carpenter, H. M.: "A System for Storage and Retrieval of Data from Autopsies." *Amer J Clin Path* 38(5):449-467, 1962.

compact, flexible, and readily available for use by all staff members without having to program or send the data to some other site for analysis. The record system has been in operation for almost two months, without any problems having arisen. It is giving the staff, for the first time, control of approximately 6,000 cases seen each year in our small animal clinic. This will be of inestimable value in teaching and in research in clinical medicine.

Satellite systems are being established in clinical pathology and in cardiovascular investigations for greater detail. We hope to establish this system for all large animals, and in all diagnostic laboratories in the near future. Termatrex quickly and easily provides the epidemiologist with the raw material necessary for investigations. In cooperation with one of our staff members, we are already planning the institution of a cancer registry based upon this record system. It is both desirable and necessary for the epidemiologist to assume the responsibility for the record system employed by the clinics of his institution.

Another area that is fruitful for the epidemiologist involves "case-finding" techniques. Years ago, I became interested in this problem when I became involved in a canine lymphoma study in New Jersey. The problem was to develop a system to receive information concerning confirmed lymphoma cases. Our solution to this problem has been described in the literature.[2]

Dr. Rhodes, staff radiologist, and I are currently engaged in a pilot study utilizing photofluorographic techniques for a canine chest survey. We are interested in this technique from the point of view of pulmonary and cardiovascular disease detection. If the technique proves feasible, we shall not only screen those dogs passing through our clinics, but have arranged to receive for screening the pets of owners who have recently been diagnosed tubercular in the city of Philadelphia and the State of New Jersey.

We are currently providing laboratory support for a project in toxoplasmosis that is being undertaken by our ophthalmologist (Dr. Rubin), a senior student (Mr. Rubin), and Dr. Leon Jacobs of the National Institutes of Health. The purpose of this study is to determine to what degree toxoplasmosis is responsible for various ocular lesions in the dog. From my point of view, this is a case-finding problem involving isolation and serologic techniques.

A few years ago, Dr. Bijlenga worked in my laboratory at the Wistar Institute on the use of acridine orange in the detection of early bovine lymphoma cases. His publication indicated the potential value of this case-finding technique.[3]

We are all aware of the two rather extensive epidemiologic surveys that have been and are currently being undertaken at the University of Pennsylvania in canine cardiovascular disease and bovine lymphosarcoma. These investigations are examples of studies aimed at finding particular cases of disease.

Case-finding is, in fact, a means of determining the numerator of a given rate. Epidemiologists are also concerned with establishing the appropriate denominators. The study of normal and hospital populations provides the baseline for all sorts of comparisons of medical phenomena. The characterization of a registered canine population, according to geographic distribution, was described by the author in relation to a New Jersey canine lymphoma study.[4] More recently, we have been attempting to characterize the hospital population at the Uni-

[2] Cohen, Daniel, *et al.*: "An Epidemiological Study of Canine Lymphoma and Its Public Health Significance." *Amer J. Vet Res* **20**:1026-1031, 1959.

[3] Bijlenga, G., *et al.*: "The Use of Acridine Orange Fluorescent Staining of Peripheral Blood Cells as a Rapid Method for the Detection of Abnormal Proliferation of Haematopoietic Tissues." *Bull Wld Hlth Org.* **26**: 688-692, 1962.

[4] Cohen, Daniel, *et al.*: "An Epidemiological Study of Canine Lymphoma and Its Public Health Significance." *op. cit.*

versity of Pennsylvania small animal clinic. We have found significant differences in the cases seen as inpatients and outpatients. This is important when one chooses to make generalizations concerning a specific diagnostic entity. We still have much to do concerning the relation between our hospital cases and the normal population from which they are derived. Demographic studies and sampling techniques will occupy an important place in our research.

In addition to the record system, the case-finding techniques, and population studies, I am also actively engaged in laboratory research in virology. It is essential for the epidemiologist to have a biologic specialty: virology, immunology, pathology, etc. This active involvement in laboratory research allows for the proper supervision of graduate students' laboratory work and provides a sounder biologic base when dealing with epidemiologic principles.

The epidemiology section at present consists of a staff epidemiologist, a statistician, a secretary, and two technicians. We anticipate that we shall acquire additional staff members for teaching and research in the near future. We are preparing to look at the problems of field trials of vaccines and the statistical evaluation of various control procedures. We hope that some arrangement can be made to assist in the training of epidemiologists for South as well as North America, and we are prepared to give technical assistance for this purpose.

In summary, I have attempted to present some concepts and experiences relating to the development of a teaching and research program in epidemiology at the University of Pennsylvania. I have described undergraduate, graduate, staff education, and research programs currently under way. I have emphasized the need for an independent discipline in epidemiology to fulfill the objectives of these programs, and hope that this discipline can be put to the test in North and South American veterinary medicine in the near future.

EPIDEMIOLOGY AND PREVENTIVE MEDICINE IN THE TEACHING OF VETERINARY MEDICINE

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For more than 20 years, and especially during the last 10, the most oustanding and qualified educators in the world have pointed out that, apart from the scientific study of the somatic aspects of disease, there have been serious shortcomings in medical education. Even more serious, because of the rapid progress made in the different areas of medical science, and the specialization required for their study, teaching has evolved in a process of splitting up of cases by species, and sometimes by individuals. This has tended to bring about in the student a "highly specialized" concept of veterinary medicine, a pre-eminent interest in the "case" rather than the patient, and a subconscious desire to learn the etiology, physiopathology, and diagnosis of the pathological process, which became more important, at times, than the desire to cure or to alleviate suffering.

The concern with giving the student as much up-to-date scientific knowledge as possible took up all the available time in a curriculum that was already overburdened, in all veterinary schools, and few opportunities were left for the student to devote attention to the study of phenomena that occur outside the laboratories and clinics and that are so important in the exercise of his profession.

Practice clinics, and above all clinics established in the schools, afford the student a view of only certain categories of illness, and in certain species of animals. The initial phases of almost all morbid conditions, a large part of the pathology in the area served by the clinic, and in general, the natural history of disease cannot be studied in such clinics through occasional and sporadic contacts between the sick animal and the student; nor can the social, economic, and ecological factors at play be duly appreciated.

It was natural that the public health veterinarians, or those who were concerned with the teaching of preventive medicine, should have been the first to feel the need for a new orientation with respect to veterinary medicine. The study programs introduced in many schools of veterinary medicine in Europe and in the Americas during the last five years bear witness to that influence.

Nevertheless, public health veterinarians have not been the only ones, and in many regions not even the first, to single out the need for modifying the teaching in such a way as to integrate in the study of veterinary medicine the concept of the biological and ecological unit and of the relationship of man to animals, without diminishing the objectivity of the scientific method nor the spirit of research that has led to so many conquests over disease.

In a large number of veterinary medicine schools in the Hemisphere, many professors of medicine, microbiology, surgery, and clinical medicine, for example, have been the most enthusiastic proponents of programs for the integration of the teaching of clinical medicine with epidemiology and preventive medicine.

This Seminar in itself shows that this

process of integration is being carried out successfully in our schools, not only through coordination in the teaching of the basic sciences, but also and above all, through coordination of the teaching of epidemiology and preventive medicine with clinical medcine and other related subjects.

Epidemiology generally has been considered a discipline of use only to those who work in public health activities, whether in schools of public health or in government or municipal health services. One could ask what value epidemiology could have for a veterinarian in private practice or in some other activity unrelated to public health. Among the various possible answers to this question, a fundamental one is that epidemiology today has the same relationship to preventive medicine that any basic medical science has to curative medicine. Paraphrasing J. R. Paul, we might say that this is a science related to the circumstances whereby one or more animals become or remain ill, and to remedy that condition it is of fundamental importance to alter those circumstances in such a way as to protect the animal or animals from a recurrence of the disease.

The use of the term epidemiology, in the modern sense, has been broadened to include the study of disease in animals and even in plants, thus giving the widest possible horizon to biology. Even though in veterinary medicine we have used the terms "enzootic" and "epizootic" to describe the incidence or prevalence of disease in animals, today it is considered correct to refer to the epidemiology of brucellosis or of bovine tuberculosis. Similarly, plant pathologists utilize the term epidemiology instead of "epiphytology" in making reference to outbreaks of infectious diseases in plants. Furthermore, although at one time epidemiology was related principally to infectious diseases, this field is now much wider and includes diseases of unknown etiology, accidents, nutritional deficiencies, and even conditions produced by physical or chemical agents.

What is epidemiology? Modern epidemiology represents, in essence, the study of the ecology of disease. If we look at a few dictionaries, we shall come across the following definitions: "Medical science treating of epidemics" (*Webster's Collegiate Dictionary,* 1953). "The study of the occurrence and distribution of disease, usually restricted to epidemic and endemic, but sometimes broadened to include all types of disease" (*Blackiston's Medical Dictionary,* 1954). All these descriptions were changed over a generation ago by scientists such as Welch, Frost, and Maxcy, who established broader and more liberal concepts of epidemiology; they considered epidemics to be only temporary phenomena or phases in the occurrence of any disease.

More recently, Paul defines epidemiology as the science "concerned with the circumstances under which diseases occur, where diseases tend to flourish, and where they do not."[1] Such circumstances may be microbiological or toxicological. They may be based on genetic, social, or environmental factors; sometimes religious or political factors exert an influence, if it is found that they have a relationship with the prevalence of the disease.

Epidemiology encompasses two concepts. It is a descriptive science used to demonstrate the incidence and prevalence of a disease, and it is a method of study. As a method of study, it is used as an ordered scientific procedure for the collection and analysis of information related to the cause and development of a disease. The line of thought and inductive reasoning that characterizes scientific method is, in essence, the same as that which the investigator, faced with a problem of diagnosis and treatment, follows in his laboratory and clinic. All these methods have as their objective the discovery of truth. But the variables involved in epidemiology demand a special attitude in that the animal

[1] Paul, J. R.: *Clinical Epidemiology*. The University of Chicago Press, Chicago, 1958, p. 9.

and the disease may be viewed as ecological entities. It is necessary also to bear in mind other disciplines that may serve to support and sustain the investigator: scientific methodology, ecology, immunology, microbiology, and others.

What are the principles of epidemiology? Inasmuch as the epidemiological method seeks a solution, the adoption of control measures is of basic interest. Their application to communicable diseases involves three basic elements—(1) source of infection, or reservoir (agent); (2) route of transmission (environment); and (3) susceptibles (host). These elements are the primary factors to be taken into account in the control of any communicable disease.

Perhaps the most important point is that epidemiology always deals with circumstances in which more than a single individual is involved, the number being inconsequential, though the "group concept" is maintained.

A place apart is assigned to the practical use or application of this science, that is, the decisions to be taken about "what to do" with the information that has been collected, or about how to alter the circumstances in such a way as to prevent or to stop the disease. Here, undoubtedly we are entering the field of preventive medicine to which applied epidemiology belongs.

On the basis of these ideas, we believe it necessary that a certain amount of time be devoted in our veterinary schools to the teaching of epidemiology and preventive medicine, since these disciplines constitute an essential part of our total professional concept. The veterinarian, because of the special characteristics of his professional duties, must always consider the group (the herd, the stable, the sty), and that is the fundamental approach of epidemiology. If we observe the work of the members of our profession, whether it be in the service of animal health or public health, in military veterinary service, in government or municipal food hygiene services, or even in private practice, we shall find that more than 60 per cent are engaged, almost exclusively, in preventive medicine activities. It is thus worth while to assess the importance of a good grounding in this field, in the light of the responsibilities and significant role that veterinary medicine has in this respect.

Dr. Hugh Leavell defines preventive medicine as the science and art of preventing disease, prolonging life, and promoting physical and mental efficiency. Public health, then, may be considered as a kind of division of preventive medicine, that is, that division which requires the action or effort of the organized community. Generally, the term public health is used in connection with a community of human beings. Veterinary public health refers to the functions of the veterinarian in the health programs carried out in that community. Nonetheless, all veterinarians, in one way or another, discharge functions in the interest of public health.

The dramatic appeal of preventive medicine is little as compared with that of medicine or surgery, and therefore it is not given due attention by the veterinarian in private practice, nor the recognition it deserves in veterinary medical education.

In Latin America, where preventable diseases such as foot-and-mouth disease, brucellosis, bovine tuberculosis, and paralytic rabies in cattle alone account for losses of some $500,000,000 a year and are thus a serious drain on the national economies, the preventive approach should prevail over all others and should predominate at all levels of veterinary medicine education.

After analyzing these ideas, we ask ourselves where and how in the veterinary curriculum these disciplines should be taught. If, hypothetically, we divide the teaching of veterinary medicine into three basic periods, we shall find the following: First, an initial period of basic sciences, which covers the teaching of subjects describing normal condition. Secondly, there is an intermediate period in which are discussed the genesis of

pathological phenomena and the ranges of abnormalities—pathology, physiopathology, infectious and parasitic diseases. In the third period, the details of individual variations in the different nosological units are studied, that is, clinical medicine, surgery, and therapeutics, together with the technical disciplines and the basic principles of administration.

From this, it can be deduced that the teaching of these disciplines should begin in the initial basic science period with instruction in the *scientific method* traditionally known as "statistics," which will acquaint the student with basic concepts of scientific methodology. It is in the intermediate period, when pathological phenomena and communicable diseases are studied, that the teaching of the *epidemiological method* of study is fundamental for an understanding of the frequency, distribution, and causes of those conditions and diseases. There remains, then, the third period, of applied studies, which should include teaching in *preventive medicine* parallely with clinical medicine, so that the student not only will acquire a knowledge of individual variations, but also study health problems in the different periods of the life of the animal, focusing his attention on the problems, not only of the individual, but of the group—that is, the different groups and species that make up the animal kingdom. The student is also taught the principles and methods of prevention, the alterations that affect the health of the animals in all stages of their lives, and the means to put at man's disposal the resources of the various branches of medicine for the protection and promotion of health. This subject may be considered as a preparation for the study of *public health,* which normally is also given in this third period of applied studies.

What should be taught in epidemiology? Considering the nature of our professional activities, one of the basic goals of the student of epidemiology is to understand the pattern of a disease. This understanding should be developed from the global as well as the regional, national and, decidedly, from the local point of view, especially insofar as practical application is concerned. The student should know the epidemiology of every disease, principally those of the environment in which he works.

We have already referred to the term "applied epidemiology," and in agreement with many authors we can also mention another term, "clinical epidemiology." But these terms are perhaps more applicable to the work of the epidemiological specialist than to the teaching of epidemiology. Dr. Enrique Pereda divides epidemiology into two types, descriptive and analytical. The descriptive type is concerned with the description of the extent, nature, and relative importance of the disease as affected by different variables and attributes (sex, age, race, species, habitat, etc.), as well as the trend it follows in the course of time and the prognosis of its future variations. He describes "analytical epidemiology" as the investigation of the causal relationships of the disease under study, its ultimate object being to aid in establishing procedures for controlling the risk, whether through diagnosis, prevention or treatment. All will agree that this is the ideal method of teaching in the field of infectious and parasitic diseases.

Epidemiology is based on three basic sciences: (1) clinical medicine, which permits the diagnosis of the disease through the systematic description of subjective and objective symptoms; (2) pathology, which permits the correct classification of the different morbid conditions; (3) statistics, which provide a method for the collection, tabulation, and analysis of data to show the relationships between facts observed, and for determining if the differences may or may not be attributable to chance.

In view of the importance of this topic, we should add that the analysis and interpretation of the data made available through epidemiology contributes to the efficient

administration of available resources, and these studies thus equip the student to appreciate administrative needs.

The use of the epidemiological method, and its refinement through the daily practice of constructive criticism, is the only means whereby the veterinarian can develop the faculty of scientific exactness, which should be the hallmark of his profession, and opportunities for contributing to the application of the basic principles of efficient public health administration.

Veterinary medicine has an essential function and responsibility in the fields of preventive medicine and public health. The veterinarian should be encouraged to participate actively in this field, to which he can contribute so much.

One of the best places to give the initial stimulus is in the schools of veterinary medicine. Dr. W. C. Hagan pointed the way when he said: "The essential work of the schools of veterinary medicine is to give a solid general and basic training in the fundamentals of science which form the basis for the prevention, control, and treatment of animal diseases, and thereafter to give to the students some indications as to the applications of the education they have received. At the same time, a sufficient proportion of time should be devoted to teaching the basic and applied phases of preventive medicine."[2]

This does not imply that every student should be trained to carry out duties as a public health veterinarian after graduation, but rather that any veterinarian, whether in public or private service, should be equipped with the knowledge that will permit him to take his place at the side of other professions in this vital work.

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[2] Author's personal reference.

REPORTING OF HUMAN AND ANIMAL DISEASES AND THE NEED FOR INTEGRATION OF REPORTING

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In order to keep abreast of public health problems, as well as problems of animal disease control, a complete and reliable system of reporting is needed. Likewise, records of deaths and sickness in both human and animal populations are indispensable to the planning of public health and animal disease control programs.

PROBLEMS OF REPORTING

While, in general, the reporting of human vital and health statistics has been more successful than the reporting of animal data, it still leaves much to be desired. In the 1957 issue of the Demographic Yearbook of the United Nations, estimates are found that show just how incomplete is the registration of human deaths. It was calculated that 90 per cent of the deaths registered in the Americas were recorded for only 12 countries and 7 political units, and the data for these was also subject to considerable error. Two countries of the Hemisphere were excluded from the estimate since they did not have such mortality data available; one of them however did report for the Federal District and capital cities. It is thus seen that there is a great need to improve the reporting of human deaths, not to mention the notifiable diseases, the reporting of which in some Latin American countries is limited to areas under the jurisdiction of local health centers. Such reporting methods naturally reflect a very small percentage of the sickness experience of the total population.

As for animal disease statistics, control officials must content themselves with reports of outbreaks and estimates of losses, a true picture of the animal disease situation being always difficult to obtain in spite of the cooperation of official veterinarians and busy practitioners.

In spite of the above, in recent years some governments have taken an increased interest in the procurement and analysis of both human and veterinary vital statistics and health data.

ANIMAL DISEASE REPORTING

The purpose of animal disease reporting is to furnish information on a continuing basis that will make it possible to estimate the losses caused by each disease, provide warning of change in disease incidence, and aid in the planning of sound preventive, control, and eradication programs.

Animal morbidity and mortality reporting programs, as carried out in the United States, are described by J. L. Hourrigan in the text *Comparative Medicine in Transition.* In 1955, an animal disease reporting system was established in the Agricultural Research Service. Good progress has been made in the last few years. Routine reports that are prepared and distributed include the following:

1. *Monthly Reports:*
   a. Brucellosis eradication
   b. Tuberculosis eradication

c. Animal morbidity reports
d. Consolidated reports (animal diseases at public stockyards and establishments)

2. *Annual Reports:*
On the same subjects as those listed above, plus reports on sheep and cattle scabies eradication; blue tongue; encephalitis and rabies in the United States.

In this country reports received from veterinarians in private practice are considered to be of great value. Deficiencies encountered in standard reporting systems may be overcome by including data from diagnostic laboratories, stockyards, and slaughterhouses and through epidemiological investigations and surveys in animal populations.

In Canada, the Animal Health Division of the Department of Agriculture publishes monthly reports on outbreaks of reportable contagious diseases of livestock and poultry. Numbers of infected premises are given, by provinces, and up-to-date figures on control activities for tuberculosis, brucellosis, and Johne's disease are included. The annual report of the Director-General gives a yearly summary of all activities of the Division, in addition to current veterinary vital statistics.

Similar reporting systems and sources are found in most other countries of the Americas. But in all the countries the lack of veterinarians, problems of communication, and the deficiency of laboratory diagnostic facilities are always limiting factors that must be taken into account.

HUMAN MORTALITY AND MORBIDITY STATISTICS

While it is generally understood that the notification of contagious diseases is an essential measure for protection of the community against epidemics, there is greater resistance to the reporting of other diseases in which preventive measures do not depend on such notification.

To help solve this problem, sampling methods in sickness surveys have been employed by public health agencies. A classic example of the use of these techniques is the Canadian sickness survey conducted in 1950-1951. The survey covered a period of 14 months, each household in the random sample being visited monthly. The size of the sample was calculated so that results would be within the margin of error 95 times out of 100.

The objectives of the survey were deliberately broad and the intent was to secure estimates reliable enough for planning and implementing health programs in three main aspects of health. These were:

a. The incidence and prevalence of illness and injuries of all kinds.

b. The amount of medical, nursing, and other types of health care received.

c. The volume of family expenditures for each of the various types of health service.

The Canadian authorities were fully aware of the experimental nature of the methods used in the survey, but were able to conclude that such methods are useful tools and that they hold for the future a wider application in demographic and health statistics.

INTERNATIONAL COOPERATION

With a view to extending international cooperation in the areas of public health, animal disease control, and livestock development, agencies such as the Pan American Health Organization, the World Health Organization, the Food and Agriculture Organization, and the Office of International Epizootics, have concerned themselves with the improvement of disease reporting methods in their member countries. In 1948 the International Lists of Diseases and Causes of Deaths were revised for the sixth time and published by WHO under the title *Manual of the International Statistical*

Classification of Diseases, Injuries, and Causes of Death. It included for the first time many categories corresponding to diseases that do not cause death. More recently, PAHO/WHO published in Spanish and distributed widely an International Classification of Diseases[1] patterned after the one published in English by the U.S. Department of Health, Education, and Welfare. This text classifies diseases and operations and serves as an index of diagnosis in hospitals.

The PAHO has a health statistics program specifically designed to assist member countries. Trained statisticians serve as consultants in all six of the Zones of the Region of the Americas. In Peru the Organization provided consultant services to the biostatistics program of the Ministry of Health, and to improve the quality of basic data, the following steps were taken:

1. Development of new instructions and standard forms for use in hospitals, in local health centers, and by physicians.
2. Interviews with units supplying basic data.
3. Short courses for persons in charge of statistics in the various services.

In Brazil the Organization is collaborating with the Federal Government in the setting up of vital statistics registration areas. It is expected that the work undertaken in such areas, now limited to the northeastern section of the country, will be extended throughout the country.

The Pan American Zoonoses Center, also a project of the PAHO, has been compiling and analyzing data on animal diseases of interest to public health. A recent publication on animal tuberculosis in the Americas and its transmission to man,[2] contains practically all the statistical data available on this disease in the Hemisphere. Government officials and private investigators from almost all countries of the Americas cooperated in this undertaking. Another important activity of the Center is that related to the standardization of diagnostic methods and procedures for the zoonotic diseases.

NEED FOR INTEGRATION OF HUMAN AND ANIMAL DISEASE REPORTING

The obvious overlap of interest in the reporting of human and animal health statistics is in the area of zoonosis control. Diseases transmissible from animal to man are of unquestionable interest to public health authorities. The reverse transmission of zoonotic infection from man to animal must also constantly be kept in mind by animal disease control authorities. The passage of human tuberculosis to animals in some European countries where bovine tuberculosis has practically been eliminated, is a case in point.

During recent years diseases of free-living wild animals and birds have received a considerable amount of attention by workers in a number of countries throughout the world. The reports received not only have added to our knowledge of the diseases themselves, which may bear on the marked fluctuations in some wild animal populations, but also point out the role of wildlife as reservoirs of infective agents for man and domestic animals. As more information becomes available, greater consideration will no doubt have to be given to wildlife as disseminators of causal agents of human disease. As far as we are aware, there does not exist today any organized service for the reporting of such specialized data to either veterinary or medical workers.

SOME OBSERVATIONS AND RECOMMENDATIONS

Today as never before, there is an awareness throughout the world of the need for rapid social and economic development. With

[1] Pan American Health Organization. *Clasificación Internacional de Enfermedades Adaptada para índice de diagnósticos de hospitales y clasificación de operaciones. Scientific Publication PAHO* 52. Washington, D.C., 1961.

[2] García Carrillo, C., and Szyfres, B.: *La tuberculosis animal en las Américas y su transmisión al hombre.* United Nations Food and Agriculture Organization, Rome, 1963, 62 p.

this awareness comes the realization that both short-term and long-term planning is essential.

The first step in planning is the collection of data. How can we define our problem or establish priorities without first having access to reliable facts and figures? Do we have these for our animal disease problem in the Americas?

What priority, for example, should be given to a brucellosis control program over the establishment of a cement works? We can only have accurate answers to such questions if we improve our animal disease reporting.

It is interesting to note that at this Seminar attention is being given to the inclusion of the discipline of statistics in the veterinary curriculum. We will all agree that the teaching of the statistical method is absolutely necessary in any scientific course of study. In addition to basic instruction on methods, we would like to insist that particular attention be paid in veterinary schools to the statistical recording and reporting of the cases of animal diseases and the collection, compilation, analysis, presentation, and distribution of statistics pertaining to those diseases.

The organization of national committees on veterinary statistics should be encouraged. The purpose of these committees would be to facilitate the exchange of information and views between the various national agencies responsible for the collection and analysis of animal disease and animal production statistics. Further aims would be to achieve essential uniformity in records and tabulations in order to produce comparable statistics needed for national and international purposes.

We would also like to see organized, possibly under the sponsorship of FAO and WHO, a Pan American seminar on animal health statistics where the following could be discussed:

a. Existing organizations and procedures for the collection of animal mortality and morbidity statistics in the Americas.

b. Methods suitable for the collection of animal mortality and morbidity statistics in the Americas.

c. Methods suitable for the collection of animal health statistics at different stages of administrative development.

d. Training of personnel for the collection and compilation of animal disease statistics.

e. Establishment of lists of causes of death suitable for use in areas where only semiprofessional or lay sources of information are available.

f. Establishment of a center for the classification of animal diseases and the standardization of diagnostic procedures. (The Pan American Zoonoses Center is suggested as a possible location.)

g. Establishment of an international classification service and coding system for free-living wild animals, to assist in the study of wildlife disease dissemination.

To meet the need for integration of human and animal disease reporting, it would seem desirable to set up some type of exchange system between specialists in veterinary and human statistics. Special tables could be published with selected data on the zoonotic diseases, as supplied by public health and animal disease control authorities.

TOPIC III

Food Hygiene

MEAT HYGIENE IN THE VETERINARY CURRICULUM

A REPORT

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The veterinarian lives in a changing world, with many cross currents of interest pulling him first in one direction and then another. These tides of influence place great stresses on the profession of veterinary medicine and challenge the leaders of the profession to use their greatest skill and understanding in providing direction for their colleagues. The social change that is sweeping the world is bound to result in broad changes in even the oldest of our service professions. Yet a profession, to remain viable, must serve the society within which it lives and breathes. When the needs of the society change, the services of the professions must also change. It is during these times that the leaders of the profession must sense the changing role of the service that the profession is to perform. By a combination of foresight and insight, the leader must prepare and smooth the change of emphasis in professional services. In providing this needed function, the leader assures that his profession maintains its high standards and codes of discipline during the process of internal evolution.

It would seem that the veterinary profession of North America finds itself at such a crossroads today. The social needs of the people are being expressed, and even demanded, more and more insistently. It has long been the custom for the private practitioner to maintain the paramount position within the veterinary profession in many parts of North America. Now, however, the role of the public practitioner is assuming a new importance in our part of the world. This public practitioner is the man who inspects the meat you eat, controls the movement and inoculation of potential disease-carrying livestock, and isolates the source of zoonoses affecting the health of mankind. As our population becomes ever larger and the needs of society ever greater, it is the public practitioner who will be increasingly called upon to provide the new services demanded by the public.

The private practitioner has done and is doing a noble job and will continue to perform his time-honored function. However, the needs of the public are always changing and growing and the trend is now unmistakably in the direction of greater public service by the professions. We, as veterinarians, would be remiss if we failed to recognize the syndrome of the changing public needs.

One of the rapidly developing needs of the Americas is that of meat hygiene. As the living standard rises, the people increase their consumption of meat protein. And with the increased consumption, there is a corresponding greater interest in the quality of the meat consumed. We, as a profession, must ask ourselves: "Who is to provide the leadership in this field of increasing general interest?" The microbiologist would welcome the opportunity to assume leadership. So would the trained sanitarian, and the food technologist. And each of these groups has many qualities and abilities of value in meat

hygiene. Yet none possesses the composite of knowledge and understanding required for the field of meat hygiene.

A comprehensive meat hygiene program must be able to accomplish the following goals:

1. Practice veterinary preventive medicine by detecting through ante-mortem and post-mortem inspections the disease conditions that could ravage the livestock industry of the nation.
2. Practice veterinary public health by safeguarding the consumer from diseases transmitted from animal to man.
3. Practice professional ethics by protecting the consumer from the sale of loathsome meats and products.
4. Practice sound economic policies by observing the public right to know what they are buying. This is done through a full and truthful labeling system.

It is obvious that one profession is pre-eminently qualified to meet the goals: the profession of veterinary medicine. The veterinarian has mastered the basic scientific disciplines upon which the study of human and animal health rests. He is a medical man. He is also an ethical man with a broad education in the humanities as well as the sciences. He, and he alone, is the natural leader in the evolving field of meat hygiene.

Since our interest today is in how to accept the challenge that meat hygiene presents to our profession, let us look at the problem from both the veterinary education point of view and from the viewpoint of the operating meat hygiene program. The majority of meat hygiene programs are administered by the national, state, or local government. A major responsibility of the veterinary profession, then, is to provide basically trained individuals for service within these government agencies. Therefore, in a sense, the agency and the school determine how a man will be prepared to serve the public in exercising his professional competence. However, the profession as a whole must understand the importance of meat hygiene to the profession and then support effective meat hygiene programs, as well as the academic changes required to provide undergraduate students with high-quality instruction in the field. In other words, if we see an effective meat hygiene program as a real need of society, then our profession must assume the leadership of this field and help the veterinary schools to adjust their curricula so that competent veterinary meat hygienists are graduating to fill the positions of responsibility in the meat hygiene programs.

Two months ago a meeting between teachers of meat hygiene from U.S. and Canadian schools and officials of the Meat Inspection Division of the U.S. Department of Agriculture was held in Chicago. The purpose of the meeting was to arrive at a model meat hygiene course that could serve as a measuring stick for each of the veterinary schools. The conclusions reached are significant and may serve as a focus of interest for schools in the remainder of the Americas as well as for nations in other parts of the world. Consequently, I should like to point out a few of the conclusions and suggest that we use these as building blocks to improve the quality of meat hygiene in other countries. I am not saying that because a model course was adopted in the United States, the same course should be adopted by those present here. However, the work done in Chicago can form the basis for our own evaluation and discussions. It is obvious that the meat hygiene problems of one country may not be identical with the problems of another. And if that is the case, the training the students receive in the different countries should differ.

It is suggested that at least 40 lecture hours be devoted to meat hygiene in the veterinary schools. The objective of the course would be to train the student in the application of basic sciences to the principles and practice of meat hygiene. Both red meats and poultry are included in the study of meat hygiene. Also, if at all possible,

arrangements should be made to spend at least another 40 hours of well-supervised experience in a meat or poultry packing plant. This practical application of the theory of meat hygiene is considered as clinical experience necessary to turn out a knowledgeable practitioner of meat hygiene. Antemortem and post-mortem inspection, as well as the study of processed food controls, should be included in the clinical experience in the meat packing plant. The emphasis of the slaughtering operations is to be directed toward making professional disposition of animals, carcasses, and parts from a suitability-for-food viewpoint.

The lecture hours would include the following:

1. *A history of, and orientation* of the student in, meat hygiene. To point out the significance of an effective program, a discussion of the diseases common to animals and man is a good starting point. Also, meat hygiene as a professional career or as a part-time function of a private practice is explored.

2. *Meat hygiene agencies* at the federal, state, and local levels are explained, with some detail about the function and operation of each agency. By being acquainted with the meat hygiene programs in effect, the student can better judge the job opportunities that will be open to him after graduation.

3. *The general principles of food hygiene,* including how a program affects the health and the economy of the nation, are analyzed. The relationship between good legislation and good program is explored and the close link between meat hygiene and animal disease control is pointed out.

4. *Environmental aspects of food production* are an important area of interest. They include sanitation principles and practices, the type of plant facilities and equipment needed, the control of insects and rodents, and a study of water purity as affected by the source and distribution system. Sewage disposal methods are also explored.

5. *Anti-mortem inspection* is discussed, with an explanation of the reasons why it is necessary, how the live animals may be passed for slaughter, condemned, or held for treatment, and what facilities are required for adequate inspection.

6. *Post-mortem inspection* would receive more attention than any other aspect of the course. The facilities needed for effective inspection are listed and the relationship between basic science and infectious agents of a health hazard to the consumer are evaluated. Esthetic considerations are dealt with and the nature of the pathology is discussed as it relates to wholesomeness. All of these considerations lead to a professional disposition of the carcass and parts, in accordance with basic and applied science.

7. *Methods of handling inedible and condemned* material and of destroying it, for food purposes, are discussed. The importance of this aspect of meat hygiene is sometimes overlooked. The removal of diseased carcasses and parts is to little avail unless the condemned material is destroyed under close supervision.

8. *The reinspection of meat food products* such as sausage, smoked ham, lard, and canned meat is essential to a complete meat hygiene program. It is during the manufacture of these products that deception or adulteration can most easily occur. A corollary feature is the application of truthful and informative labels to the meat products.

9. *Meat microbiology and chemistry* tell what occurs during the various processing and preservation treatments. Included would be evaluations of the effect on meat of freezing, rendering, canning, curing, and heating. The irradiation of meat and its effect on muscle tissue is included.

10. *The principles of food poisoning* and the way in which handling and storage practices aid or retard bacterial growth is explored. The microbiological and chemical contaminants are identified and epidemiological studies are described.

11. *Chemical residues* are of increasing importance in meat hygiene, owing to the widespread use of new toxic herbicides and insecticides. The veterinarian must know which chemicals are the ones of concern, how they are to be used, their toxicity to man, and their importance as a health hazard when found in the tissues of meat animals.

12. *Parasitology* as it applies to meat hygiene is important from a health viewpoint in all parts of the world. The study of trichinosis, cysticercosis, and other parasites transmissible from animal to man should either be carefully studied as a section of the meat hygiene course or reviewed fully if the basic information is presented elsewhere in the curriculum.

This brief review of the components of a meat hygiene course, as viewed in the United States and Canada, can be used as the basis for a similar study at this Seminar, or on a broader scale, in the Latin American nations. However, you are the leaders and consequently must accept the responsibility for guiding the change toward a broader, more comprehensive training in meat hygiene.

With your skillful direction, meat hygiene can become one of the real bulwarks of our profession in the future. The assurance of a clean, wholesome meat supply is a worthy service and one the veterinarian must be well-qualified to perform.

TOPIC IV

Teaching of Statistical Methods and Their Application

THE TEACHING OF STATISTICS TO MEDICAL STUDENTS

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Karl Pearson, in his life of Francis Galton, recalled that in 1900 the council of the Royal Society of London passed a resolution recommending that "mathematics should be kept apart from biological applications." But the advancing tide of quantitative biology could not be held back, and today it is hardly necessary to argue the case for familiarizing medical students with statistical ideas. Overtly, or by implication, statistical concepts lie at the heart of much recent thinking about biological problems. And a knowledge of statistical methodolgy has become an essential part of the medical scientist's equipment; for whether he is working in the laboratory, at the bedside, or in the field of population studies, he is faced with the fact that most medical problems have of necessity to be examined through a grid of interrelated physiological, psychological, and social variables. It is true that, after qualification, the majority of medical students will have little opportunity to use statistical methods in their practice, but if they are to read medical books and journals critically they will certainly need to be familiar with the use, limitations, and abuse of the commoner statistical procedures. For the clinical textbooks are still littered with dubious numerical statements about prevalence, prognosis, predisposition, and treatment; and a rash of significance tests and scatter diagrams has now spread to the pages of even the weekly medical journals.

The need for medical students to be aware of the importance of the statistical way of looking at medical problems and to have some understanding of the general principles that underlie the statistical method of handling and interpreting biological data may be obvious; but how that awareness can best be developed, and the principles taught, is still far from clear. In 1962, at the request of the World Health Organization, I inquired about the teaching of statistics in the 27 undergraduate medical schools of the United Kingdom. I found that there was little agreement about aims and methods, and that the content and extent of teaching in the various schools appeared to depend as much upon the interests and background of individual teachers as upon any clear idea of what and how much a medical student needs to know.

At six of the 12 undergraduate schools in London, the subject is not taught, although the problem of how to introduce it into the curriculum is said to be under review. At the four schools in Scotland, at the schools of Wales and Northern Ireland, and at seven of the nine English schools outside London (the exceptions are Oxford and Cambridge) a place has been found for it in the curriculum, but the amount of time allocated varies enormously from school to school, ranging from one hour at Liverpool to more than 40 hours at Aberdeen. Responsibility for the teaching is also very varied. There is a chair in medical statistics at only one undergraduate medical school (Belfast), and the subject is most commonly taught from the department of social medicine (or its equivalent). At some schools, however, departments of physiology, biochemistry, or pharmacology have taken the initiative and in a few instances a university department of statistics

plays an active part in the teaching. At most schools the course of instruction is voluntary in the sense that there is no examination in the subject, and students' reactions to the teaching range from (at the best) tolerance to (at the worst, and more commonly) active dislike. The teachers themselves often express dissatisfaction with present arrangements and indicate that substantial improvements need to be devised.

Before I discuss the purpose of teaching statistics to medical students, what they should be taught, and how, when, and by whom the teaching should be done, it will be helpful to consider why the teaching has developed so erratically and is in general still so unsatisfactory.

WHY THE PRESENT POSITION IS UNSATISFACTORY

There is little doubt that in the past the main barrier to the advance of statistical teaching in medicine has been a general and deep-rooted antipathy on the part of most clinicians to any form of numerical thinking. This was perhaps due in part to a feeling that the statistical approach to medicine conflicted in some way with the humanitarian bedside approach of the doctor to his patient. It was due also to the fact that, until recently, few of the multitude of remedies in the therapeutic armamentarium could stand up to critical appraisal, and consequently there was an understandable reluctance to put any of them to the numerical test. Since the introduction of the sulphonamides and the antibiotics, this reason for a clinician's aversion to statistics has been removed. The doctor today has a great deal more to offer his patients than diagnostic acumen, relief from pain, and a comforting bedside manner; now he can often provide prophylactic, curative, or palliative treatment, the effectiveness of which has been convincingly demonstrated by statistical methods. Nevertheless, curriculum committees still tend to be weighted with clinicians who, if not hostile to statistical teaching, consider its claim to space in the crowded curriculum of low priority.

Unfortunately, the amount of space needed for an effective course of statistical teaching is considerable. It is possible, though not easy, for a good teacher to arouse students' interest in the need for an informed numerical approach to medical problems, and to make them aware of some of the dangers of accepting figures at their face value in a short course of four or five one-hour lectures. Many more hours of teaching time are needed, however, if students are to be taught to interpret laboratory tests and bedside observations and measurements in the light of what is known about physiological variation and observer variation; to understand the statistical principles underlying the design of laboratory experiments, therapeutic trials, and population surveys; and to be given some idea of the sources and reliability of morbidity and mortality data. If to this is to be added instruction in the simpler statistical procedures, with perhaps a little practice in the collection, sorting, tabulation, and interpretation of data, the demand for teaching time becomes formidable—so formidable that in many schools this would be regarded as an insuperable obstacle to the introduction of a satisfactory course.

An important contributory cause of the present unsatisfactory position of statistical teaching is the shortage of suitable, qualified teachers. A very persuasive voice is needed to convince undergraduates of the relevance of numbers to medicine, and teaching material has to be related closely, forcefully, and convincingly to their laboratory and clinical interests. This calls for either a doctor with special knowledge of statistics, or a statistician with biological interests. There are very few medically qualified statisticians; non-medical statisticians with a biological background are almost as difficult to find, and when found have to be persuaded that university life has advantages that outweigh

the attractions of the salary they can command in industry or with the drug firms.

Another difficulty arises out of the wide variation in mathematical ability of medical students. This, no doubt, is attributable in part to the great variety of teaching methods used in schools. It seems likely also that medicine is selective for students with less than average aptitude for figures—perhaps the mathematically inclined are attracted by the more scientific disciplines. Whatever the reason, the teacher gets the impression that among medical students the ability to assimilate statistical ideas and to handle numerical data is so variable that formal instruction in large classes is not very effective. It also adds to the difficulty of small-group teaching and practical work. A mathematically gifted student with a slide-rule or book of logarithms will produce an answer to a problem that the teacher has posed before many of his fellows have grasped its meaning. And there will be one or two students in the group who are so mathematically obtuse that they are virtually number-blind.

The allocation of a place for teaching statistics at too late a point in the medical curriculum is also a reason for unfavorable reception of the subject. There is much to be said for introducing a developing mind to the statistical way of looking at natural phenomena at school. In 1952 the Teaching of Statistics Committee, appointed by the Royal Statistical Society, presented a memorandum on the teaching of statistics in schools. It underlined the broad educative value of the statistical approach and the way in which it can "help the citizen to play a proper part in the everyday life of a democracy" by encouraging "a habit of disciplined thinking about ordinary affairs in terms of quantities," and it went on to "urge that the subject should be introduced into all secondary schools as part of the general education." If everyday examples are chosen and everyday words are used, a good teacher should not find it difficult to arouse in older children an interest in the ideas of randomness, probability, frequency distribution, and sampling, by getting them to collect data relating to their everyday interests, to subject them to simple manipulations, and to speculate on their significance. Unfortunately, however, there are still few schools where this is done, and responsibility for inculcating the statistical approach into young minds remains with the universities. The earlier this is done the better. By the time a medical student has reached his fourth of fifth year—and this is when the subject is commonly taught—he is too absorbed by the fascinations of clinical practice to pay much attention to, or see the relevance of, statistics to medicine. Even if he does, the critical and logical edge of his mind is likely to have been blunted by the preceding years of fact-cramming, and he will find it difficult to reorientate himself to the statistical way of looking at things.

Another common cause of difficulty is the placing of too much emphasis on arithmetical and algebraic procedures, and too little emphasis on the ideas and general principles underlying the statistical approach to biological and medical problems. It is not easy to achieve a satisfactory balance between systematic instruction and intellectual stimulation, between the acquiring of facts and the understanding of principles; but there is no good reason why medical students should be made to grapple with even moderately advanced statistical procedures or to learn by heart a series of mathematical formulae.

There is one other point to which reference must be made: the question of an examination in the subject. In the United Kingdom it is now the fashion to decry compulsory attendance at lectures and to play down the need for written examinations. However, without one or the other, it is quite unrealistic to expect students to pay any attention to what most of them regard as at best a marginal, and at worst an irrelevant subject. Of the two methods of compelling attention, a written examination is both more in keeping with the university idea and more effective.

Against this background I propose to consider what medical students should be taught, and how, when, and by whom the teaching may best be done.

WHAT TO TEACH MEDICAL STUDENTS

We must be quite clear in our own minds about the purpose of teaching statistics to medical students, before we attempt to discuss what the content of a teaching program should be. It is certainly not to enable them to design their own experiments, conduct their own surveys, or analyze their own research data. This type of teaching is a postgraduate matter. The basic purpose should be to help them to acquire what Bertrand Russell has described as "the habit of forming opinions on the evidence and of holding them with that degree of certainty which the evidence warrants." At a more superficial level it should be to help them to read their medical books and journals more critically, to appreciate the value and limitations of numerical statements about medical matters, and to avoid the commoner mistakes in the interpretation of the results of clinical and laboratory experiments and of population surveys.

What statistical ground needs to be covered if medical students are to be helped to acquire these habits of mind? Most teachers would probably agree that all of the following subjects should be discussed:

1. The idea of a frequency distribution, and the need for measurers of dispersion and summarizing indices, and their implication in relation to natural variability and to physiological and biochemical norms.

2. The idea of sampling, and the problem of bias, observer variation and patient variation in relation to clinical measurements, the design of experiments, and population surveys.

3. The statistical concepts of chance and probability, and the rationale of significance tests, and their use and abuse in relation to medical problems.

4. The concept of correlation and of concurrent and causal relationships.

5. The use of diagrams and their abuse: what diagram is appropriate for a given purpose and how to construct it; how to interpret diagrams; and how to recognize when they have been misused (deliberately or subconsciously) to lend support to doubtful arguments.

6. The use of percentages, ratios, and rates; the sources, imperfections, and limitations of official local, national, and international medical statistics; and the need for standardization when comparing data from different sources.

HOW TO TEACH MEDICAL STUDENTS

Although most teachers would agree in principle with the program outlined above, answers to the questions when, by whom, and in how much detail the component parts should be taught, remain very much a matter of personal opinion. In the introduction to their Recommendations as to the Medical Curriculum, the General Medical Council in 1947 agreed that it was important for medical students to acquire some knowledge of statistical method, but they thought it "preferable not to include in the new recommendations any provision as to the period during which, or the relation with other subjects in which, it should be taught." This has left medical schools with plenty of room for maneuver and experiment, and in some instances an excuse for doing nothing. In consequence, as we have seen, practice varies widely from school to school. On this difficult and still controversial subject, I can offer no more than a personal opinion, based directly on teaching experience in two medical schools and indirectly on knowledge of recent developments in other schools in the United Kingdom.

The following general principles offer a guide to what is required:

Medical students must be made familiar with the statistical approach and its relevance to biology at the earliest possible moment in their university training.

The need for the numerical approach to biological and medical problems must be given proper weight throughout the medical curriculum, from the preclinical years onwards.

The subject must be taught by people with a direct and day-to-day interest in medical problems. This does not mean that the teachers need to be doctors. It does mean, however, that the approach should be biological and medical rather than mathematical.

Because of the wide range of mathematical ability found among medical students, teaching should as far as possible be in small groups, and sophisticated algebra and too much tedious arithmetic should be avoided.

If these principles are accepted, it follows that the subject does not easily lend itself to being taught to medical undergraduates as a separate discipline, but is more readily introduced in relation to their immediate interests at successive stages in their training. To this end the teaching may conveniently be divided into three parts: (a) general principles and methods; (b) the application of statistical methods to medical problems; and (c) vital and health statistics.

GENERAL PRINCIPLES AND METHODS

This course is best given alongside anatomy, physiology, and biochemistry and, for it to be effective, at least 10 one-hour periods of formal teaching are needed. Its purpose is to introduce students to the problem of the variability of physical, physiological, and biochemical measurements in man; to the ideas of normal and continuous distributions, summarizing indices and measures of dispersion, population and sample, and probability and correlation (and its interpretation); and to the application of these ideas to the design of experiments and surveys. A supplement of practical work is necessary. In this respect, measurements of arterial pressure taken with the mercury sphygmomanometer in the physiology laboratory provide excellent material not only for illustrating how a physical attribute is distributed in a sample of the young adult population, but also for discussing the problem of observer variation in clinical medicine.

THE APPLICATION OF STATISTICAL METHODS TO MEDICAL PROBLEMS

The need for a statistical approach to the design of laboratory experiments can be pointed out in biochemistry and pharmacology, and the complications introduced by observer variation can be further illustrated in the context of the students' own laboratory work. In the teaching of therapeutics, an opportunity is provided to enlarge upon the problem of bias in sampling, to indicate how therapeutic trials are planned, and to explain the rationale of the simpler tests of significance. At the same time, the student can be taught to regard with a sceptical eye the therapeutic claims made in breakfast-table medical literature. The need for and value of properly controlled trials of prophylactic therapy can be illustrated during bacteriological teaching with the examples of BCG and the poliomyelitis vaccines.

Clinical medicine presents many opportunities to remind students that in the population biochemical measurements are continuously distributed, and that consequently there is no clearly defined line between the normal and the pathological. Attention can also be drawn to the complication of observer variation in the interpretation of diagnostic procedures such as chest X-ray and electrocardiography, and even in the recording and interpretation of symptomatology. These ideas are perhaps best imparted at

the bedside or in the side ward by means of joint teaching sessions held by the departments of medicine and of social medicine, with active student participation. In addition, while the student is studying clinical medicine, there is a place for discussion in small groups of selected articles drawn from recent issues of medical journals, to illustrate the presenting of numerical data, the interpretation of tests of significance, and above all, the need for a careful and informed statistical approach to a medical investigation and a logical presentation of its results.

HEALTH AND VITAL STATISTICS

This part of the course finds its natural place in the teaching of social and preventive medicine and allied subjects. It will include size, structure, movement, and growth of populations, sources of mortality and morbidity data, summarizing indices in common use, factors influencing health (biological and social), methods of measuring and comparing the health of populations, and the numerical description and evaluation of health services and their activities. There is a tendency to separate this material from the main body of instruction under the heading of vital or medical statistics, but it is probably more effectively presented, and it is certainly more readily accepted, as illustrative material in the general teaching program of social medicine.

Teaching statistics in the manner outlined above has two great advantages; by allowing the subject to permeate the whole of undergraduate training, it overcomes the difficulty of finding a separate place for it in the over-crowded curriculum; and by always relating the subject to his current biological and medical interests, it holds the student's attention. The program has, however, one disadvantage: it is difficult to present the subject matter of a discipline in a coherent fashion when it is divided between many teachers. Until each medical school has a department of statistics, responsibility for coordinating the teaching and for ensuring that the necessary ground is covered must rest with the department of social medicine, and members of the department should participate in the teaching at every stage.

STATISTICS IN THE MEASUREMENT OF DISEASE

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A good deal of the functioning of statistics is devoted to the counting and measuring of events and things, and the organization of the resulting numbers into forms that will allow general conclusions to be drawn. So, in the assessment of disease, counts and measures are used to answer questions that deal with what may be considered forces (of morbidity and mortality) acting on a population. These forces may be made up of very complex components, but the end result can be expressed simply in terms of the events that are produced by them. We can in fact write, in a general sort of way:

$$\text{Population} \times \text{Force} = \text{Events}$$

and, if we want to estimate the size of the force, we can transpose and get:

$$\text{Force} = \frac{\text{Events}}{\text{Population}}$$

The last term is in the form of what is called an *incidence rate,* that is, a number of events counted, over a stated time, referred to the average population in which they occur. The rate can then be used to compare the relative size of forces in different populations or in the same population at different times, a greater force being implied by a higher rate. Rates are generally multiplied by some convenient factor, as 1,000 or 100,000, which will yield a reasonable number in front of the decimal place. In making comparisons, the base of the rates must be checked to see that it is the same. For example: 30 deaths occurring in a town with an average 2,500 population during a year would be expressed as 30/2,500 or 0.012 or 12 per 1,000 (written 12/1,000) per year—a "crude death rate."

There is another type of relation referring to the action of a force on a population. That is (assuming steady states):

$$\text{Events} \times \text{Duration} = \text{Existence}$$

which can be illustrated by the fact that, in a stationary population,

$$\text{Births} \times \text{Average length of life} = \text{Population.}$$

This leads to another sort of rate:

$$\frac{\text{Existence}}{\text{Population}} \quad \text{or} \quad \frac{\text{Events} \times \text{Duration}}{\text{Population}}$$

which measures the relative prevalence of a condition in a population at a point in time: the *point prevalence rate,* or simply *prevalence rate.*

Clearly, the two rates do not measure the same thing and cannot be directly compared. The prevalence of a disease depends on two factors: its incidence rate and its duration. The incidence rate of tuberculosis may be lower in white than in nonwhite, yet the prevalence rate may be higher because the disease is more chronic and has a longer duration and therefore more cases exist, relatively, at a given instant.

There are two ways of getting information for the construction of rates: either we go out to do our own measurements and counts, or someone else does them and tells us about them, directly or by way of published reports. Either way, the counting of events and of existence implies two different methods. Counts of events must be made by someone who is on the spot when things

happen: the doctor who sees a case of illness, or the undertaker who buries a body. The construction of incidence rates by the counting of events implies at least three separate procedures, each of which must be checked for validity:

1. *Recognition:* Has the person who reports the event sufficient knowledge to identify it when it occurs? This covers a wide scale of abilities. Almost anyone can recognize death, but it takes considerable expertise, as well as laboratory equipment, to make a credible diagnosis of infection by some obscure virus. In accepting the figures of a published disease report, one should always ask himself whether the reporter had a valid basis for diagnosing the disease; in comparing rates from different reports, the relative efficiency of the reporters must be weighed, as well as their threshold of definition of a "case," which may vary from an almost imperceptible infection to a lethal process.

2. *Reporting:* What is the mechanism of transmission of the information to the organization issuing the report? Does it tend to accumulate all cases recognized, or only a variable fraction? What is the constraint on reporting? Death reports, for instance, are generally more nearly completely reported than disease notifications, because the mechanism usually requires a report for disposal of the body.

3. *Classification:* When a complex of several conditions is reported, generally only one is included in the tabulation, as for example, the "cause of death" selected from a death certificate. The more or less arbitrary choice of a most significant condition may introduce considerable variation between tabulations made by different people and at different times. This will introduce little confusion in the case of an obviously overriding pathology, such as fatal infectious disease, but may prove confusing when it is a case of the occurrence of a chronic disease in the company of others, any of which might have been fatal.

Prevalence rates involve a different mechanism. The existence of a condition must be determined in a population, or usually a sample. This is done generally by a survey or a census; the survey may be performed by ourselves, in which case we should have a fairly clear idea of our definition of a "case" and the methods used to determine it. Our own survey results should be reasonably comparable between different populations and times, provided we make sure that we always measure in the same way. It is somewhat harder to be sure that prevalence rates as determined by different observers are strictly comparable. It was, for instance, difficult for two observers to arrive at the same figure for enlarged spleen rates in the same population in estimating malaria prevalence, even though they had been trained together and presumably used identical scales. To be meaningful, the surveyed sample must of course be representative of the whole population.

Incidence and prevalence rates clearly have different functions. Incidence may be determined fairly easily in acute diseases in which the onset is definite and easily diagnosed, provided an observer is there to record it. Prevalence, on the other hand, would here be a poor measure because it fluctuates rapidly with the course of an epidemic and may be low shortly after the peak has been reached. The opposite is true for chronic disease in which fluctuations are slow and in which the onset is usually indeterminate within wide limits, the date of report or of first discovery usually being used, instead, to calculate incidence rates. Incidence may be calculated from repeated prevalence surveys, on the basis of new cases occurring in the interval. It may be estimated from a single prevalence figure if a reliable assessment of the average duration can be made. Under certain assumptions, another type of estimate can be made from the gradual increase, with age, of the proportion of the population showing evidence of past infection.

Anything expressed in numbers automat-

ically assumes a sort of magic property of exactness that attaches to anything associated with a figure. The precision of the number is unconsciously taken to reflect the preciseness of the information on which it is based. This is not necessarily true; occasionally it is far from the truth. In order to avoid wrong deductions and unfortunate conclusions, there are certain questions that must be asked before one evaluates statistical evidence, especially when it is expressed in rates.

To begin with, a rate has a numerator and a denominator. We sometimes forget this and inspect only the numerator, oblivious of the fact that the rate is influenced by its denominator as well. Some of the questions asked of the numerator may well be: What data are included? Are they the proper figures to answer our questions? Who gave us these data? Was he competent to collect them? Did he know what he was doing? Was he thinking of something else? How were the data obtained? By methods consistent with our understanding of pathology? At what threshold of definition of a "case"? When were the data obtained? Near enough in time to be reliable, or so long ago that almost everything has possibly changed? Finally, why were the data collected? For some specific purpose, to answer a definite question, or as a matter of routine? Or just out of curiosity?

There is a definition: "Statistics is like garbage, because once you collect it you must do something with it." Many accumulations of statistics are made with no particular end in view, and are analyzed merely because it seems such a shame to throw them away. This rarely results in fruitful conclusions.

There are also questions to be asked of the denominator. The first sounds silly: Is there any at all? If so, does it include the "population at risk," that is, the one among which the events counted actually took place? Does it exclude, as far as possible, parts of the population not at risk? To measure a force, events must be counted in the population on which the force acts, and the rate must be based on that population. The force of measles morbidity, for example, can be measured more accurately by excluding from the denominator that part of the population already immune; those over 15 years old, for example. It would be even more accurate to base the rate entirely on those susceptible to measles, but this figure is hard to come by except on the basis of careful surveys in limited population groups.

Various types of rates measure various forces. The main ones are of the form: event/population *(incidence)* and existence/population *(prevalence)*. There are others, such as event/event, like the infant mortality rate in which deaths under a year of age are referred to live births during the same year, since the latter are usually a better estimate of the infant population than the census figure. Then there is the type existence/existence, of which point prevalence is an example. One example of the type event/event is the proportional mortality rate. This rate, which is simply the proportion of all deaths during a period assigned to one cause, has its uses but must be handled with extreme caution. It has no population at risk and so measures no risk. It is sometimes used on primitive countries without vital statistics, on the basis of hospital data, to estimate changes in certain causes of death. For example, if 10 per cent of all hospital deaths last year were caused by malaria, and only 5 per cent this year, the force of malaria may have decreased by half; or it may have remained constant while other forces doubled; or other reasons might have kept malaria cases from coming to the hospital.

Any rate may be said to answer a question. It is sometimes not easy to determine what question is answered by the rate, or whether it is the one asked. A frequent statistical fallacy is to accept a rate as answer to one question while, in fact, it applies to an entirely different one. For example, the crude birth rate for New York City in 1957 was 20.3/1,000 while "upstate" (the remainder of the state) it was 23.3 per 1,000 total population. The ratio of the

city rate to the remainder was 0.87. On the other hand, the rate per women aged 15 to 44 years was 91.2 in the city and 113.9 upstate—a ratio of 0.80 and perceptibly lower. The difference is that the first rate is "demographic" and combines the two factors of proportion of childbearing women in the population and their individual production in producing increase of population. The latter eliminates the factor of population composition and deals with individual production; it is a measure of "fertility." Clearly, each rate answers a somewhat different question and the two must not be confused with each other, though each is legitimate in its place.

Three rates of great interest in measuring forces of disease are morbidity *(incidence),* mortality, and case fatality. These three are closely interconnected. Morbidity is defined as:

$$\frac{\text{Cases of disease occurring during period}}{\text{Average population}}$$

while mortality is:

$$\frac{\text{Deaths from disease during period}}{\text{Average population}}$$

Case fatality (an event/event rate) is:

$$\frac{\text{Deaths from disease during period}}{\text{Cases during period}}$$

It is therefore possible to write:

$$\frac{D/P}{C/P} = \frac{D}{C} \text{ or } \frac{\text{Mortality rate}}{\text{Morbidity rate}} = \text{Case fatality}$$

or:

$$\text{Mortality rate} = \text{Morbidity rate} \times \text{Case fatality}$$

It can therefore be seen that mortality is really made up of two independent components: the force of morbidity acting on the population to produce disease, and the force of mortality acting on the cases to produce death. Mortality can vary with changes in either rate, or both. For example, mortality rates of diphtheria and of scarlet fever have, in recent years, shown an almost parallel decline. Case fatality of diphtheria, on the one hand, has changed relatively little while morbidity has shown a sharp drop, presumably the result of toxoid immunization campaigns. The case of scarlet fever is just the opposite; morbidity has remained almost constant but case fatality has decreased a great deal, probably owing to the newer treatments with sulfa drugs and later antibiotics. It is clearly essential, in studying changes in disease mortality, to take both factors into account.

There are many ways in which rates may be misinterpreted. Some of these fallacies are obvious while others may be quite difficult to detect. For instance, a statement was recently made in the daily press that 61 per cent of all automobile accidents involved drivers who had been driving for more than 10 years, while only 21 per cent had driven between 6 and 10 years, and 17 per cent for 5 or less. The conclusion stated was that drivers tended to get more careless as the years rolled on. This is a case of "no denominator"; there is no population at risk, and no age distribution of all drivers. There is only a proportion distribution of ages of accident drivers, a type of "proportional mortality." Silly as it seems, this sort of fallacy is often met with, usually in the daily press but sometimes in more pretentious "scientific" articles. It is a case of: "White sheep eat more than black sheep—because there are more of them."

More often, a rate may measure a hidden variable and not the one that is apparent. For example, the death rates of males over 15 years of age are highest in the widowed group, next highest in the married, lower in the divorced, and lowest in the single. Interpreted at their face value, these figures might be taken as strong advice against marriage and urgent counsel for early divorce if one accidentally finds himself a bridegroom. This association disappears when the factor of age is considered; for equal age groups the order is quite different. Married men then have lower death rates than single, and widowed and divorced men have the highest. The main factors in the first rates were the differences in average rates of the groups, from the youngest (single) to the oldest (widowed). Even

the corrected rates cannot be interpreted in terms of cause and effect. Do married men live longer because of their wives' tender care, or are healthy men more apt to get married than sick ones? Which is cause and which effect? This brings up another important point. We must always turn a question both ways and ask: is A due to B? Or B to A? Or could both of them be due to some outside factor that we are not measuring? In general, statistics point to associations without indicating their direction.

An interesting case is that of a prominent physiologist who found a high degree of association between reported intake of animal fat in the diet of some populations, and the reported level of deaths from arteriosclerosis. Further analysis showed, among other things, that the association was even higher with animal protein. Evidently one or more hidden variables could be involved.

The statement is often heard that the risk of malformations is greater among white babies than among nonwhite. In a recent publication, such a statement was based on the following figures:

	All deliveries	*Deaths*	*Malformations*	*Malf./Deaths*	*Malf./Deliv.*
White	23,729	868	128	14.7%	5.4/1,000
Nonwhite	2,094	132	13	9.8%	6.2/1,000

The author based his statement on the ratio of malformations to all deaths, which shows a considerably higher value for whites. This is a proportional mortality and so not a measure of risk. Referring the deaths to the real population at risk (all deliveries), it is seen that there is no difference to speak of. The proportion of malformations in dead babies is lower in nonwhite merely because there are so many other forces of mortality. The question answered by the proportional mortality is: Given a dead baby, is it more apt to be malformed if white or nonwhite? This is not the question that was asked.

It has been said that the reporting of cases of disease is generally unsatisfactory; only a fraction are ever reported, and this fraction varies with the general interest and importance of the disease. This would not be so bad if the proportion remained the same, because then the variation of reports would be a correct index of the disease situation. But the recognition and reporting of diseases vary considerably between times of epidemics, when doctors are aware of them, and times when there are no epidemics, when cases are less apt to be recognized. A case in point is the poliomyelitis reported in New York City in 1949. The total reported incidence was 31/100,000, but the secondary incidence among families of primary cases was 1,317/100,000, or some 40 times higher. The divergence may have involved various causes. First, there is a real danger of family contact; this apparently played only a small part, because most secondary cases followed the primary within their incubation periods. Second, there is the probability that several members of a family jointly had contact with the same source. Third, a home with a case of poliomyelitis is apt to have more children, whose incidence rate would be high. Last, and most important, once a case has been diagnosed the doctor is thinking of the disease and recognizes in others symptoms that normally he would pass over. What would usually be called an intestinal upset (and sometimes is one) becomes suspect polio. The matter of diagnostic threshold is very important in comparing rates from different sources.

In making comparisons it is important that both populations enter into the account completely. It is misleading to compare numerators only and to neglect denominators. One of the best and simplest devices for making comparisons is the fourfold table that divides the data into four cells:

		Factor A		
		Present	*Absent*	*Total*
Factor B	Present	a	b	a + b
	Absent	c	d	c + d
	Total	a + c	b + d	a + b + c + d = N

Without this minimum account of information in four cells, no estimate of association can be made. Consequently, if any item of the four is omitted, no estimate is possible. The table can be analyzed in different ways. One measure of association is the "relative risk," which is simply the ratio ad/bc. If this has nearly the value of 1, the two variables are independent; if it is larger, there is positive association: one variable goes with the other, as polluted water and typhoid fever. If it is less, the association is negative: the presence of one variable goes with the absence of the other, as vaccination and smallpox.

It is good practice to put data into the form of a fourfold table to see whether all necessary information is provided. If all cells are not filled, no conclusions can be drawn. A good many studies suffer from the fallacy of the "empty cell." For example, some years ago a small-film chest survey was done for tuberculosis in an urban population. It was decided to investigate the possibility of using this method as a screening device for clinical heart disease and accordingly a sample of films was read with this aim in view. Individuals with suspect films were subjected to a thorough clinical examination and the proportion of subjects with suspect films who showed clinical heart conditions was calculated. Despite arguments, no sample of negative small films was followed up, on the plea that clinical examinations were too costly to waste on negative material. If the results are put into a fourfold table, they look like this (the figures are not accurate):

		Clinical Heart Disease		
		Present	*Absent*	*Total*
X-ray	Suspect	10	90	100
	Clear	900		900
		?	?	1,000

There is, then, no possible way of estimating the advantage of using screening over the simple process of going into the street and picking subjects at random. A good deal of expensive work led to no useful result.

As another example, some time ago the U.S. Public Health Service announced that, in the previous year, only 10 per cent of reported cases of poliomyelitis had received Salk vaccine. This, they felt, indicated 90 per cent efficiency of the vaccine. When the data are put into fourfold form, they show:

		Vaccinated		
		+	−	*Total*
Polio	+	10	90	100
	−	?	?	?
Total		?	?	?

An inspection of the table shows that the statement makes no sense at all.

The fourfold table is generally tested for "significance" by the method of chi-square, which can be calculated in different ways. "Significance" merely tests whether an observed difference could be due to chance or whether we must assume that some factor has operated. The basis of the test is to assume that there is really no difference in the origin of the two samples ("null hypothesis") and to ask: If this is true, what would be the chance of accidental differences as large as the one observed, or larger? If this probability is appreciable, nothing more can be said about the difference; it may be real, but there is too much possibility that it is due merely to chance. If

the probability is small, the null hypothesis is rejected and the decision is made that there is a real cause for the difference.

What that cause is, does not immediately become apparent. It may be due to the factor we are investigating; it may also be something associated with this, as age was associated with marital condition. It may be the result of the selection of the sample with which we are dealing, which favors one group over another. Thus, it is common to find advantages ascribed to some new treatment for which subjects were carefully selected from the most promising patients and whose results are compared with those of the old treatment that was given to the remainder of the group, who were poorer risks. In interpreting results as due to direct associations between stated variables, it is necessary to make sure that, insofar as possible, other sources of variation have been equalized so that they will not contribute to the differences.

The laboratory experimenter can carefully equalize his variables and make sure that no extraneous factors enter unequally. The field investigator, or epidemiologist, must deal with facts as they are provided by a totally unplanned experiment conducted by nature. Factors can be interrelated in many ways. Sometimes it is possible to eliminate the effects of some variables by comparing groups in which they are equalized. For instance, in tracing the sources of an epidemic of food poisoning, the association with an item of food is separately calculated in subgroups that did and that did not also eat some other item. When it is impossible to rule out the effect of outside variables, we must come to our conclusions with a lively sense of possible errors that may have entered into our estimates, and approach our findings in a humble and guarded spirit.

We must remember that the value of statistical analysis lies in its ability to generalize: to take data obtained from a sample and to apply them to the whole population from which the sample comes. We are no longer interested in the sample itself, which is past, except for what it can tell of the future. Does vaccination confer protection against disease in the group studied? If so, it will do so in the entire population, provided that (a) the difference is "real" and not possibly due to sampling deviations, like cards in successive hands of a game; and (b) the sample truly represents the population from which it comes and not some aberrant group that reacts differently from the remainder. To ensure the validity of both postulates may involve a good deal of statistical knowledge and procedure, but in general mistakes will be minimized by the use of common sense and a critical and skeptical look at the source of our figures, with some idea of what to look for.

TOPIC V

Curriculum Content

PUBLIC HEALTH ORIENTATION OF THE UNDERGRADUATE VETERINARY STUDENT
A GUIDE TO THE TEACHING STAFF

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VETERINARY MEDICINE IN A CHANGING WORLD

Man has always lived close to animals and depended upon them for survival. First he trapped and hunted for food and clothing; later he domesticated animals for food, transportation, power, companionship, and pleasure. As human and veterinary medicine advanced, man found even greater uses for animals. In the development of drug potency and toxicity trials, surgical procedures, effective vaccines, and other phases of medical research, including the exploration of space, animals have contributed a great deal to the health of people, livestock, and pets. However, in time and through medical progress, man realized that animals, as well as being beneficial, often endanger human lives because some animal diseases are transmissible to man. For centuries epizootics, or animal epidemics, threatened the extermination of animals man depended upon, but not until the Pasteur era did man realize that these diseases posed a threat to his own health.

The word *zoonoses* is applied to infections of animals that are secondarily transmissible to man. Rural people generally contract these diseases through the handling and slaughter of livestock or the consumption of diseased milk or meat. Routes of infection—skin, mouth, respiratory tract—offer unlimited opportunities for the exchange of the infectious bacillary, viral, mycotic, and parasitic agents. Each year "new" or variant disease strains found in animals are added to the growing list of zoonoses, which now number more than one hundred. Although the common means of infection is direct contact with infected animals or consumption of their products, infection is often acquired through vectors, such as plague-infected fleas and encephalitis-infected mosquitoes. In dealing with the zoonoses we need to know more about ecology, or the mutual relationships between living organisms in the environment.

Another major broad area of veterinary public health is the interprofessional team approach to comparative medicine and all its aspects. Included would be the role veterinarians are playing in space medicine, radiobiology, laboratory animal medicine, and chronic disease research. The research effort against the great killers of mankind throughout the world—cancer and heart disease—are classic examples of the value to be derived from the comparative approach to disease. In both areas, veterinarians are working with physicians and others in an attempt to conquer these diseases. One veterinary school in the United States (University of Pennsylvania) has received a $1,100,000 grant to study comparative cardiovascular disease and has been designated by the World Health Organization as the world center for training scientists in comparative aspects of cardiovascular disease. Other veterinary schools in the United States have extensive research projects directed toward the problem of the

relationship of viruses to cancer in man and animals.

Another vital area involving veterinary medicine in a changing world is the problem of feeding a hungry world with wholesome food. Dr. W. R. Pritchard, Dean of the School of Veterinary Medicine, University of California, lists two main responsibilities of veterinary medicine to our society:

a. It must provide the means for maintaining the health of man's food-producing and fiber-producing animals, as well as of draft, companion, feral and other animals so that they may serve the purposes for which they are kept.

b. In conjunction with appropriate medical agencies, veterinary medicine must develop and implement control measures for diseases that animals may transmit to man.

In order to meet these responsibilities, veterinary students must be taught as much as possible about the diseases of all kinds of animals and how they interact with man. For a moment let us look at our role in the first responsibility and see how it is related to the very survival of man. People have existed without automobiles, television, bathrooms, and even clothes or houses, but they have never existed without food. The primary human needs are food, shelter, health, and recreation. Health is dependent upon food, and more than two-thirds of the world's population is underfed and poorly sheltered. A former Director-General of the Food and Agriculture Organization, in commenting on the magnitude of the world-wide problem, stated: "It is not the atomic bomb, but the food crisis that may destroy us." In a recent article Dr. Frederick Stare, Head of the Department of Nutrition, Harvard School of Public Health, stated: "The harsh realities of life on earth stand out in even more alarming perspective when we consider the possibilities of subsistence against the prospect of our exploding world population. If more than half of the three billion people now in the world do not have enough to eat, what are we to do with six billion mouths a generation hence?"

With the breaking up of the colonial empires of the nineteenth and twentieth centuries and the emergence of a series of new nations, there has risen a host of world problems, other than political, that are related to the food crisis. One is the serious shortage of veterinarians in these new nations, which may result in a complete breakdown of disease control. This is of concern to the older nations because many of these destructive diseases can easily be conveyed by modern traffic from one country to another. For example, at the present time it is believed that fewer than 100 veterinarians remain to serve the great livestock population of the vast central area of Africa. The ratio of veterinarians to livestock units is probably greater than 1:1,000,000. In Europe it is 1:7,000 and in the United States, 1:20,000. If these problems are not solved they could become an invitation to world disaster.

The relationship of veterinary medicine to the problem of feeding a hungry world, the control of the zoonoses, and the broad area of comparative medicine have been mentioned in these introductory remarks because they are basic to the understanding of the efficient teaching of veterinary public health in our schools of veterinary medicine. Unless the teacher and the student are properly oriented to the problems of our society, how can such a vast amount of information be imparted to the student so that he may make a worthy and satisfying contribution to the society in which he lives?

RESPONSIBILITY AND PUBLIC HEALTH

The teacher and the student should be well oriented to the broad problems affecting our society today and the role of the veterinary profession in the solution of these problems. The veterinary profession can be proud of its contribution as an active, par-

ticipating member of the health team. It is unfortunate that in the past we have often exhibited many symptoms of an inferiority complex. Human medicine and veterinary medicine cannot be divorced and members of both professions need to consider the tremendous importance of one to the other. We must also understand clearly our responsibilities as well as our opportunities.

Public health methods have in many ways shaped the civilization in which we live. The development and survival of our modern society is closely related to public health advances. In my introductory remarks a somewhat alarming picture of the critical food shortage was described, but there are bright areas. The prevention of the spread of communicable diseases and the control of fatal epidemics permit two-thirds of the world's population to live safely in crowded cities. The world-wide population explosion, as well as the increase in the aged population, are further evidences of public health victories.

For practical purposes, public health may be defined as the application of scientific knowledge for the protection and promotion of man's health. It is unfortunate that many scientific principles that public health workers can apply may be capable of causing serious harm. Antibiotics infused into the cow's udder to provide disease-free milk may sensitize an individual to these life-saving drug. Radioactivity, which can be harnessed to detect and prevent disease, may also be directed into a hydrogen bomb for man's destruction or contaminate his food supply through fission products. Advances in microbiology have provided many disease-preventing vaccines as well as methods for effective biological warfare. Insecticides developed through chemical research may become dangerous poisons or carcinogens when used on or around farm animals and products. Hormones, antibiotics, and other additives fed to livestock as growth-stimulating substances may be dangerous to the farmer who handles the product and to the consumer if not properly administered or withdrawn before slaughter. Farm ponds developed for irrigation and recreation may become reservoirs for outbreaks of human and animal leptospirosis or places where children accidentally drown. These examples illustrate the judgment necessary in the practice of public health, and this judgment must be imparted to the student by an enthusiastic, well-trained teacher.

The practice of public health is not merely the application of physical and social sciences as they relate to health. It also calls for ethical and political judgment. It draws upon ethics because public health activities must be assessed in terms of the good and the harm they might do. It is political in that it entails decisions affecting the future of populations. I have attempted to describe briefly an area where both the teacher and the student must be knowledgeable if our profession is to make its maximum contribution to our society.

PRESENT AND FUTURE AREAS OF INVOLVEMENT IN THE TOTAL HEALTH PROGRAM

Veterinary medicine is moving through a period of sweeping transition, striving to meet the challenges of a swiftly changing world. The role of the veterinarian is becoming more far-ranging, more vital, domestically and internationally. To meet these challenges our schools of veterinary medicine must widen their educational outlook and reorient their academic aims. The Council on Education of the American Veterinary Medical Association is making plans for a seminar to study and explore all facets of veterinary education in the United States. Our educational philosophy must continue to provide broad training, but must be enlarged in depth. The veterinarian has long been known for his versatility, but the veterinarian of tomorrow must be not only a biological scientist but a social scientist

as well, knowledgeable in economics, politics, law—and still be a good veterinarian. In his community, as a successful practitioner he must be skilled in treating large and small animals, serve as an adviser to governments in public health, know how to treat zoo animals, be familiar with an array of regulatory animal disease programs, and remain active in civic, church, and political organizations. This means that our schools must keep their curriculums in a constant stage of re-evaluation and revision.

As we strengthen the curriculum, the problem of career recruitment becomes more serious. We face strong competition in attracting the best students and we must offer them the best education possible so they will be challenged and encouraged. To attract, encourage, challenge, and prepare often necessitates curriculum change. Consideration should be given to adding standard courses and providing a program of electives and advanced courses for the more capable student. At the same time we must give more attention to the field of humanities and social sciences in the pre-veterinary curriculum. Veterinary students should be internationally oriented, with more understanding of the cultures and ideologies of other nations and a knowledge of their human and animal health problems. We live in a "shrinking world" because of modern-day travel, and what is your problem today may be our problem tomorrow. We must run to stand still. If we are to keep up in a changing world, it is inevitable that some courses must be scrapped and others telescoped to make room for change. Each year the veterinary schools in the United States receive increased requests for veterinarians and many of these are to fill positions in institutions and corporations where veterinarians were never before employed. Many graduates become involved in basic medical research and most of our medical schools utilize veterinarians in full faculty status. Laboratory animal medicine, radiobiology, nutrition, toxicology, humane work, military veterinary medicine, chronic disease research, world health, and space medicine are a few of the newer fields that will employ more veterinarians in the future, and most of these are directly or indirectly related to public health. If we who are active today do our jobs with imagination, we shall assure an expanding role for veterinarians in the future.

PUBLIC HEALTH IN THE PROFESSIONAL CURRICULUM

Veterinary curriculums have been developed chiefly for the graduate who will engage in clinical practice, yet 40 per cent of our graduates today enter other fields such as research, teaching, industry, and military and public health. A majority of the 60 per cent who enter practice participate in one or more government health programs on a part-time basis. No other profession has such diversification of responsibilities with respect to public welfare, and this creates additional problems in the field of education.

I am persuaded that professional training should be kept as broad as possible without too much emphasis on any specialty. We must teach students to be good veterinarians in whatever area of the profession they engage. They should know what their responsibilities are with respect to public health, but they should not be made "public health veterinarians," which would involve the sacrifice of adequate training in other fields. In my opinion, the majority of veterinary practitioners have no conception of the administrative organization of a local or state health department, and there is a marked lack of understanding of how the practitioner can work with his local and state health department. Recent graduates seem to be divided in their opinions on public health as taught in schools in the United States. Some believe that more time should be spent on public health; others feel it is a waste of time. The majority seem to agree that

present teaching is not well organized or presented. It appears that our major problem is to decide what should be presented and arrive at an appropriate time and place in the curriculum for its presentation. Last but not least, a qualified, enthusiastic teacher must be recruited who is skilled in the art of "weaving" public health subject material into the total curriculum, so that it will be accepted by both faculty and students. Our schools must continue to carefully indoctrinate students as to their future responsibilities as veterinarians. If a student is permitted to go through school with the feeling that he can slant his interest solely toward small animal practice or some other specialty, then we are failing in our responsibilities. Interest must be stimulated in all fields, because the degrees are granted in veterinary medicine and not in a particular specialty.

Dr. Kenneth L. Crawford, in a review[1] of curriculums of schools of veterinary medicine with reference to content in the field of public health, found a wide variation of course objectives in each of 18 schools contacted. For example, Dean I. A. Merchant of the School of Veterinary Medicine, Iowa State University of Science and Technology, explained the college's method of the teaching of public health context as follows: "Instead of having a separate course relative to public health, we try to weave into our various courses those relationships to man as they are encountered. I have found quite a number of years ago that this is a better approach than to try to single out material under the term 'public health' and then have it repeated in many courses. In this way, the student gets an over-all picture of matters of health pertaining to animals and man. However, our courses of meat and milk sanitation are separate, as they are applied courses."

In contrast to the above method of attempting to weave public health relationships into related curriculum courses, as cited by Dean Merchant, the Ohio State University provides a detailed itinerary for the senior veterinary student. This consists of a quarter in which a group of students register for off-the-campus training, utilizing various public health facilities and governmental public health programs in an urban area. This program of training includes activities at the federal, state, and local government levels. A portion of the training at all levels is to participate in and observe the various programs of disease control and eradication.

Some interesting facts revealed in the Crawford report are the following:

1. Thirteen departments within schools of veterinary medicine are staffed with graduates of schools of public health who occupy teaching positions where they can teach the principles of public health.

2. One half of the schools have public health courses per se, taught in departments where public health is combined with the bacteriology department, and one third of the schools combine it with the pathology department. In two schools the public health department has singular status. Public health was found to be departmentalized within the 18 schools in nine different ways. This wide variation developed because of the variety of motivating forces for the teaching of public health. Early in the twentieth century, for example, the need for meat and milk inspectors made it necessary to associate public health with sanitation and contagious diseases, and the public health courses were established in bacteriology and pathology departments. The staffs of these departments were best qualified to understand the interrelated disease processes of maladies receiving public health emphasis at that time. At present, all schools are placing emphasis on the relationship of the zoonoses and environmental sanitation to public health, and some schools have introduced new courses to deal with

[1] "Partial Requirement for the MPH degree at the School of Public Health," University of North Carolina, Chapel Hill, N.C.

public health problems created since World War II. Some schools offer courses in the principles of public health, health education, biostatistics, and epidemiology but these courses have not been developed to such a degree as to encroach upon the curriculum areas of specialized courses presented in schools of public health.

3. Sixteen per cent of the schools are restricting the teaching of public health courses to the last quarter or last semester of the college curriculum. Schools that introduce these courses in the second year are perhaps reaching the student at a more impressionable period of development, since fourth-year students usually have decided upon a specialty and have definite plans and commitments for the future.

4. Twelve schools give curriculum credit for a formal course in the principles of veterinary public health. The objectives of these courses are to introduce the student to the general principles of public health, its scope, and the role that veterinary practitioners may be asked to play in public health activities. These courses often indicate areas of public health where the veterinarian can gainfully use the knowledge and skills of his discipline to contribute to the effective management of public health problems.

5. "Milk and meat" courses have reached the stage where they are recognized as "the public health courses" of veterinary curriculums. Federal regulations governing meat, milk, and poultry shipped in interstate commerce have been expanded in recent years, making it desirable that veterinary students be aware of and trained for these activities. The states have also extended their programs. In 1961 North Carolina approved a $1,000,000 program for the inspection of meat and poultry shipped in intercounty trade. The Armed Forces utilize the services of veterinarians as commissioned officers, to safeguard their personnel against zoonotic diseases and to ensure that foodstuffs for consumption by the troops meet minimum quality standards. The above reasons are justification for the rather uniform inclusion of these courses in the curriculums of veterinary medicine. It is my feeling that they should be called veterinary public health courses, when listed in the general catalogue, rather than food hygiene.

6. Curriculum credit is given for "field work and orientation," in varying degrees. In some schools the curriculum is designed to take advantage of excellent food-processing facilities in the area, as well as of various governmental programs of disease control and eradication. The Ohio State University awards 15 quarter hours credit for field work. Texas A. and M. University and Oklahoma State University transport students from rural areas to urban areas where public health activities can be observed. Other schools have similar programs.

7. Five schools have courses in biostatistics and epidemiology. Several schools introduce these subjects as a part of other courses.

8. Ten schools indicate that curriculum changes in public health content are being considered.

It is apparent from the Crawford report that there is no specific pattern of departmentalization of public health within the organizational structure of schools in the United States, and that public health courses vary from school to school because of the varying competency of instructors and interest of deans. The schools are appointing greater numbers of public health specialists to their faculties, and as a result, considerable attention is being given by planners of veterinary curriculums to biostatistics, epidemiology, laboratory animal medicine, research methodology, and other areas related to the broad field of public health. Areas of public health which veterinary curriculums have not fully covered are: the principles of public health administration, the principles of public health education, the function of instrumentation in biostatistical

analysis of epidemiological studies, and the actual designation of credit hours for public-health-related field work and orientation. A vital area that should be re-evaluated is the need for the early introduction of the student to a course in the principles of veterinary public health. The schools, I believe, have uniformly accepted the mission of orienting the student to the significance of the zoonotic diseases, as well as of acquainting him with the public health aspects of veterinary problems affecting the well-being of the world's population.

HORIZONS IN VETERINARY EDUCATION AS RELATED TO PUBLIC HEALTH

From the previous comments on the status of curriculums in schools of veterinary medicine, it is obvious that faculties and deans must first be motivated in the subject of public health, with emphasis on its broadest aspects. They, in turn, will then be more apt to motivate their students. Too many members of our profession (including faculty members) have become so engrossed in veterinary medicine per se that they lack the perspective to consider it a part of the broad field of medicine in general.

For the past three years it has been my privilege to represent public health on the Council on Education of the American Veterinary Medical Association. When the various schools are evaluated, I often attempt to determine the degree of "cross-fertilization" of faculties of the veterinary schools with those of the nearby medical and public health schools. Sometimes it is excellent, other times non-existent. Unfortunately, some of our teachers believe that veterinary public health consists of meat and dairy hygiene, and therefore are living in the "horse and buggy days." There really is no one area that can be called veterinary public health, but there are veterinary medical aspects of public health problems that can best be solved by veterinarians working with other members of the health team. Actually, there are few subjects in present curriculums that are not related to public health in some way. Formal courses in public health are needed, but they will not train the student to take his place on the public health team. There must be a continuous effort on the part of each department and staff member to relate the responsibilities of the veterinarian to the welfare of his community. In order to broaden the veterinarian's understanding of the society in which he lives and works, and also of the problems of other professions, arrangements should be made with physicians, dentists, lawyers, bankers, school superintendents, ministers and others, for talks and conferences with veterinary students. The instilling of a professional awareness of social responsibility in the minds of veterinary students should be regarded as an essential function of veterinary education. Practitioners who have participated in public health activities should be invited to discuss their experiences with advanced students. The word practitioner, in my opinion, refers to any veterinarian, whether in general or specialized private practice, teaching, research, diagnosis, public health, or anything else within the broad field of veterinary medicine.

Modern veterinary education lays a good foundation for advanced study and work in public health. I have mentioned departmentalization as well as the integration approach, and these are matters for each school to decide. Certainly no attempt should be made to standardize curriculums as to what should be taught and how. We must, however, be alert to the constant state of change in our society and adapt curriculums to meet change and challenges. The veterinarian of tomorrow, whether he be in private practice, regulatory work, medical research, or organized public health, must have a comprehensive knowledge of modern public health problems and of the contribution he can make toward solving them. I

have listed below some of the important subjects that should be considered in the planning and re-evaluation of curriculums of veterinary medicine. These are not listed by priority and, of course, many are already being taught today. Most of them could be considered subspecialties in the broad field of public health.

1. An introduction to biostatistics, to give the student an appreciation of accurate mortality and morbidity reporting as well as an understanding of statistical procedure.

2. Current knowledge of the control, treatment, and eradication of the zoonoses throughout the world, as well as of foreign animal diseases that threaten the livestock economy (and indirectly public health) in other countries.

3. An understanding of radiobiology, including the effects of total and partial body radiation on various tissues and the problem of radiocontamination of food products of animal origin through fallout.

4. An introduction to comparative medical research, including the study of pathological conditions that affect both animals and man, such as heart disease, cancer, arthritis, diabetes, and others. The student should be acquainted with the rapidly developing specialty of laboratory animal medicine, as well as with the useful role that the veterinarian in private practice can play by observing, reporting on, and participating in research projects while he observes and treats these diseases in animals.

5. Thorough knowledge of the latest developments in nutrition as related to an adequate and wholesome supply of animal protein in the human diet, including the rapidly developing problems connected with the use of antibiotics, hormones, insecticides, pesticides, and other chemicals and additives used on or around animals intended for human food.

6. Knowledge of the use of numerous types of animals in the exploration of space, and the role played by the veterinarian in this activity.

7. Knowledge of the principles of public health practice and administration and of epidemiology.

8. An introduction to disaster medicine, including the role of the veterinarian in nuclear, biological, and chemical warfare as well as in natural disasters.

9. Thorough knowledge of recent developments in the area of meat, milk, and poultry inspection programs involving veterinary medicine.

How can all of this be included in a curriculum already crowded? During a talk before the First Institute on Veterinary Public Health Practice, held in Ann Arbor, Michigan, 6-9 October 1958, Dr. Mark W. Allam, Dean of the University of Pennsylvania School of Veterinary Medicine, used the following phrase, which I like very much: "Courses in veterinary medicine should be salted generously with public health."

This is a philosophy shared by many deans, but it may be easier said than done. Several things are needed to make this philosophy work. The first requirement is a faculty aware of the role of the veterinarian in public health. The second requirement is a qualified professor with practical experience in public health who has received advanced training at a school of public health. This person should be responsible for coordinating, weaving, integrating, and "salting" public health into the curriculum by helping the faculty emphasize the public health implications of their specialties. The third requirement is to orient the student in a palatable way so that he will develop an appreciation for public health and for the role he will play in any area of veterinary medicine in which he chooses to practice. When the interrelationship between animal and human disease is emphasized in every department on every possible occasion, there will be few graduates who are not cognizant of their public health responsibilities. The schools have also failed to impress upon the student the fact that many of the methods used in public health

can be used as well in the control of animal disease problems.

SUMMARY

Veterinary medicine, as a profession, has grown in stature since its formal inception in 1761. Interest in veterinary public health has developed rapidly in the United States in the past 15 years. During this period the American Board of Veterinary Public Health, the Conference of Public Health Veterinarians, and the Association of State Public Health Veterinarians have been organized. In addition, the First Institute on Veterinary Public Health Practice has been held and the proceedings published.

A current concept receiving support by leaders in public health is the application to public health problems of combined knowledge from multiple disciplines. This concept is finding approval in many schools of veterinary medicine, as evidenced by the increased number of public health specialists employed by veterinary schools, by the addition of courses in areas of public health activity and concern, by the increased teaching of public health relationships in all courses in the veterinary curriculum, and by the re-evaluation of the public health content of existing curriculums.

A well-educated and informed veterinary profession is the key to providing effective veterinary public health programs throughout the world. Our schools must prepare the students today for their role tomorrow.

The graduate level of public health training for the veterinarian has not been discussed, but I should mention that 11 schools of public health in the United States accept veterinarians as candidates for advanced degrees. Here the veterinarian is acquainted with the role that other disciplines play in public health. It has been my privilege for the past six years to serve as a visiting professor at the School of Public Health of the University of North Carolina. I have had the opportunity of teaching the relationship between veterinary medicine and public health to physicians, dentists, engineers, health educators, entomologists, laboratory workers, and many other professionals. This has been a challenging and rewarding experience for me, and I hope that in the future every school of public health in the Americas will have a veterinarian as a member of the faculty.

THE TEACHING OF PUBLIC HEALTH IN OUR SCHOOLS OF VETERINARY MEDICINE

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The subject of teaching public health in our schools of veterinary medicine has been studied by various college curriculum committees and numerous educators have expressed their views in articles written on this subject. It would appear from the available information that the vast majority of our educators are in complete agreement that the teaching of public health should be an integral part of the undergraduate professional curriculum of our veterinary colleges. The same individuals that are in agreement that this subject should be taught, are not generally agreed as to how and to what extent public health teaching should be integrated in the teaching program. In this respect, I hasten to state that how this teaching is implemented in a school is a matter for the faculty of that school to decide. In my opinion, their recommendations will be influenced to a considerable extent by:

1. The existing departmental make-up of the school.
2. The availability of cooperating agencies that can support the applied teaching program.
3. The established teaching assignments and attitudes that prevail.

For most of us it is very hard to make changes. Some may think that changes in departmental organization and curriculum theoretically should not be difficult to accomplish; however, in reality the attempt to change may present as much of a problem as a major reorganization of the college. We should nevertheless be receptive to warranted changes and remember that it is often through changes that progress is made.

I am not in accord with the idea that public health teaching should be restricted to formal lecture-type courses. The seminar and on-the-job training approach as a supplement to lecture orientation should be encouraged. Public health teaching should be the role of every basic and applied teaching area in the college, and instructors should point out the health aspects of their particular subject as well as the curative medicine or surgical aspects.

I doubt that it is in the best interest of public health teaching to create a special department for this area. The vital functions and objectives of public health, animal disease eradication, meat inspection, food hygiene, environmental sanitation, epidemiology, and the study of zoonotic diseases, etc., are all directed and geared to a preventive type of medicine. From a teaching point of view, it is more practical to provide the applied emphasis and coordinate the supervised experience of these disciplines in an area of preventive medicine, rather than to separate the various disciplines into entities of their own. The fundamental principles and basic science knowledge will apply to all of the disciplines. A person well grounded in public health is of necessity well grounded in the basic sciences. This concept applies equally to animal disease eradication, meat inspection, and the other foregoing disciplines. The teaching of the applied aspects of public health in a preventive medicine area affords many advan-

tages and opportunities to work as a team and to recognize the importance and necessity of good liaison between the various disciplines. The success of public health and various animal disease control programs is greatly enhanced when good liaison exists between the agencies concerned.

Public health teaching is in some respects everyone's responsibility, but occasionally, what is everyone's business sometimes ends up as no one's business. I believe that instruction in this area should be introduced early. It should be presented on a par with other major disciplines and preferably taught in a department that is concerned with the basic and applied practice of preventive medicine. It is not enough to be satisfied with the classroom lecture method of teaching preventive medicine. We recognize the value of laboratory experience and on-the-job training as a supplement to our lectures in all other areas of our curriculum. The applied training programs in our colleges are developed to be in alignment with the anticipated tasks and duties of general practice. In the absence of an internship, it is the policy of most veterinary schools to provide applied experience in the important areas of practice. Our veterinary hospital and ambulatory clinic programs are excellent laboratories for various phases of applied training in medicine and surgery. The hospital is not sufficient to teach applied preventive medicine. The opportunities provided by municipal and state health departments, abattoirs under federal inspection, federal and state regulatory agencies, state-institution-owned herds and flocks, and a medical school, all can considerably enhance the opportunities for an applied training program in preventive medicine and public health. In all possibilities, any of these agencies will generously cooperate and be willing to contribute their facilities and animals to the program and even provide personal assistance during the interim required for the department to develop faculty supervision for the program.

The public expects our graduates to be reasonably proficient in applying basic information relating to the field of medicine and surgery. Today more than ever before, the public also looks to the veterinarian for guidance in matters pertaining to preventive medicine. It is desirable that our graduates possess reasonable proficiency in this area. Public health teaching is an important discipline, and I recommend that, whenever an opportunity is presented, it be incorporated in the applied teaching area.

Annex

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Appendix

MEETING OF THE COORDINATING COMMITTEE ON THE TEACHING OF PREVENTIVE MEDICINE AND PUBLIC HEALTH IN SCHOOLS OF VETERINARY MEDICINE IN LATIN AMERICA

Report of the Meeting Held 19-21 October 1964, in Chapel Hill, North Carolina

I. BACKGROUND AND INTRODUCTION

In recent years two Seminars on the Teaching of Preventive Medicine and Public Health in Schools of Veterinary Medicine in the Americas were sponsored by the Pan American Health Organization: the first held in August 1959 in Kansas City, Missouri, and the second in August 1963 in Mexico City, Mexico. The proceedings have been published for wide distribution among the schools and other interested persons. During the Seminar in Mexico City, a recommendation was made that the PAHO appoint a Committee to collaborate with it in evaluating the progress achieved in carrying out the recommendations of these meetings, and in organizing future Seminars. In requesting that this Coordinating Committee be established, it was the hope of the participants that some procedure could be established whereby all the veterinary schools could be assisted in improving the teaching of preventive medicine and public health and that progress to this end would be continuous, with eventually all schools operating under essential minimum standards.

II. ORGANIZATION OF THE COMMITTEE

In December 1963 Dr. Carlos Díaz-Coller, Chief of the Professional Education Branch, Pan American Sanitary Bureau, requested that Dr. Martin P. Hines, Director of the Division of Epidemiology, North Carolina State Board of Health, serve as Consultant to the Coordinating Committee and that a meeting be held at the School of Public Health of the University of North Carolina, Chapel Hill, in October 1964. Several conferences were held in preparation for this meeting.

The following participated:

Dr. Adolpho Ribeiro Netto, Professor of Hygiene, Public Health, and Biostatistics, School of Veterinary Medicine, University of São Paulo, São Paulo, Brazil

Dr. Enrique Mora Campos, Professor of Public Health, School of Veterinary Medicine, University of Chile, Santiago, Chile

Dr. John Wright, Director, Continuing Education, School of Public Health, University of North Carolina, Chapel Hill, North Carolina

Dr. Abraham Drobny, Chief, Office of Evaluation and Reports, Pan American Sanitary Bureau

Dr. Pedro N. Acha, Regional Veterinary Public Health Adviser, Pan American Sanitary Bureau

Dr. Martin P. Hines, Director, Division of Epidemiology, North Carolina State Board of Health, Raleigh, North Carolina

III. AGENDA

The agenda was designed to encourage the broadest possible discussion and to bring out the viewpoints of those with varying background and experience. The primary purpose was to exchange thoughts on how to implement the recommendations of the two previous Seminars, and to make recommendations to the Pan American Health Organization as to what should be done in the future regarding the teaching of preventive medicine and public health.

The first day was devoted to a discussion of several broad subjects related to the purpose of the meeting. Dr. W. F. Mayes, Dean of the School of Public Health, University of North Carolina, brought greetings to the group. Dr. Mayes emphasized that more and more veterinarians were assuming responsibilities beyond those limited to the field of veterinary medicine. He suggested that the Committee consider the following four objectives of the teaching of preventive medicine and public health in schools of veterinary medicine:

1. To emphasize the importance of public health to veterinary medicine.
2. To emphasize the importance of veterinary medicine to public health.
3. To emphasize the above two as a combination.
4. To emphasize the role of veterinarians as administrators of broad public health programs.

Dr. Mayes also informed the group that the American Public Health Association has a Committee on Professional Education which will provide, upon request, liaison to various public health professional disciplines concerned with the evaluation of educational standards.

Dr. Pedro N. Acha reviewed the highlights of the previous Seminars and the progress made to date. He also commented on the needs and perspectives in veterinary public health in the Latin American countries.

Dr. Martin P. Hines reviewed the minimum standards for the teaching of preventive medicine and public health in schools of veterinary medicine in the United States. He also reviewed the system of evaluation and accreditation for the 18 schools in that country. That evaluation covers the entire curricu-

lum, physical facilities, and equipment of each school and is carried out by the Council on Education of the American Veterinary Medical Association.

Dr. E. Mora of Chile and Dr. A. Netto of Brazil outlined the programs of teaching preventive medicine and public health in their respective schools. The purpose of those presentations was to give the group insight into what is now being taught by two different schools using different approaches and methods.

The group adjourned at 3:00 p.m. on the first day to attend a Student-Faculty Seminar at the School of Public Health of the University of North Carolina. Dr. Robert C. Cook spoke on "Public Health and Population Growth."

Dr. A. Drobny opened the second day with a discussion of the basic principles of evaluation and their application in education. He urged the group to avoid competitiveness in attempting to compare the teaching program of one school with that of another. He emphasized the fact that requirements vary from country to country, and suggested that additional teachers need to be trained. In discussing evaluation, he mentioned three important points: What are the general objectives? What is the baseline? What is the target? Dr. Drobny then suggested the need for an impersonal organization or association of teachers of preventive medicine and public health, as a starting point. When that was done, decisions could be made as to the number of professors needed to teach these subjects, minimum standards could be established, and the percentage of theory and practice in the curricula could be balanced.

The remaining portion of the second day and all of the third day included discussions on the establishment of minimum standards for a department or chair of preventive medicine and public health. All participated in these discussions.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. That an organization or association of professors of public health and preventive medicine be established:

Time and time again, the group returned to the great need for an "impersonal" organization which could earn the respect of all the schools of the many countries in Latin America. The group was of the opinion that a Council on Education, like that in the United States, would be excellent for any one country, but would not be feasible for an area consisting of many countries. The possibilities of what a strong, respected organization could do are unlimited, but of immediate concern would be the promotion of minimum standards, the distribution of reports, the holding of training conferences, and the publication of a newsletter to provide needed communication between the schools in the various countries. Eventually, the association might sponsor on-the-spot visits by a team of expert advisers, when requested. The major objective of such an organization would be the general upgrading of veterinary education, with special reference to the teaching of public health and preventive medicine.

B. That complete curricula of all schools in the teaching of preventive medicine and public health be collected and distributed to the veterinary medicine schools in Latin America:

Attached to this report are the data currently available to the Pan American Health Organization on schools of veterinary medicine in Latin America. This information is not believed to be completely accurate and there is little detail available. There is a great need for the compilation and distribution of complete data at this time, and it is recommended that the PAHO undertake this task, until such time as the afore-mentioned organization or association is formed.

C. That a Training Conference for teachers of preventive medicine and public health be sponsored by the Pan American Health Organization in 1966 at a central location in South America.

The group was of the opinion that the two previous Seminars served a very useful purpose and that definite progress has taken place following them. At these Seminars the underlying philosophy and the necessity of a strong program of teaching veterinary public health were explored and documented, and similar Seminars would serve no useful purpose at this time. What is needed at present is a Training Conference wherein professors of preventive medicine and public health can obtain the latest information on subject presentation, on the use of visual aids in teaching, and on other up-to-date teaching methods. This would be a working conference lasting perhaps six weeks or more, and a teaching faculty would be carefully assembled. The Pan American Sanitary Bureau could use its consultants to promote awareness of the need of such a Training Conference among the various schools during the year preceding the proposed 1966 meeting.

D. That the following "Orientation Guide for the Teaching of Preventive Medicine and Public Health" be distributed to all deans and professors of veterinary public health of the schools of veterinary medicine:

In preparing the following Guide, the group constantly stressed the need to think in terms of minimum standards rather than ideal standards. A look at the data available on what is now being taught at some schools will reveal the need for the immediate implementation of such a Guide. It includes three areas for consideration, namely, professional teaching staff, teaching facilities, and subject content:

1. *Professional Teaching Staff*

One professor should:

(a) Be employed full time.
(b) Have specialized training in public health.
(c) Coordinate other related courses of veterinary public health in other departments, chairs, or units.

(d) Have at least one assistant for laboratory, field work, and practical exercise.
(e) Invite guest lecturers with practical experience, where possible.

2. *Teaching Facilities*
(a) Adequate library facilities should be available.
(b) Visual and teaching aids should be adequate.
(c) Transportation for students (buses and cars) should be provided.
(d) Adequate field and laboratory facilities and equipment should be furnished.
(e) Facilities of other professions and agencies should be utilized.

3. *Subject Content*
(a) Environmental Sciences:
(1) Meat products hygiene.
(2) Milk products hygiene.
(3) Other animal food products for human consumption.
(4) Water supply.
(5) Human and animal waste disposal.
(6) Vector control.
(b) Principles of Public Health Administration:
(1) Laws and regulations.
(2) Organization, functions, and relationship with official and voluntary agencies having a health-related program.
(3) Fundamentals of health education.
(c) Epidemiology:
(1) Principles and practices.
(2) Epidemiological method.
(3) Surveillance and reporting.
(d) Zoonoses:
(1) Epidemiology of selected diseases of regional importance.
(2) Prevention and control.
(e) Food-borne Diseases:
(1) Investigation.
(2) Infection and intoxication.
(f) Statistics:
(1) Statistical methodology.
(2) Description of sampling data.
(3) Statistical inference:
(a) Test of one means.
(b) Test of two means.
(4) General principles of experimental design.

With respect to the above recommendations, it was pointed out that the subject content is not listed by priority, and that in reality it constitutes a reaffirmation of the recommendations made at the Second Seminar in Mexico City in 1963.

The group spent considerable time discussing the need for stronger veterinary leadership in Latin America. Few positions of administrative importance are held by veterinarians in the various countries. Veterinarians must be

trained to assume important roles of leadership and, in turn, high government officials must be convinced that the veterinarian is ready and able to assume these roles. To attain that goal will require, first, the recruitment of excellent students to study veterinary medicine, and second, elevation of the standards of veterinary medical education. Progress is being made but much remains to be done before veterinarians can make their maximum contribution to the society in which they live.

CURRENT DATA ON SCHOOLS OF VETERINARY MEDICINE IN LATIN AMERICA

(October 1964)

I. *General Information*

1. There are 30 schools of veterinary medicine in Latin America. Twenty-eight are owned by the State and two by the State and other sources.
2. Total enrollment in 1963 at all schools was approximately 6,500. Fourteen hundred students were admitted in 1963 but only some 400 completed the prescribed course.
3. The duration of the course is:
   (a) Six years for 2 schools.
   (b) Five years for 18 schools.
   (c) Four years for 10 schools.

II. *Teaching of Veterinary Public Health and Preventive Medicine*

1. Four schools have a department of veterinary public health. (Many schools have chairs of veterinary public health, but the chair may teach several other subjects.)
2. Thirteen schools listed courses in veterinary public health, and 13 others included veterinary public health with other courses. Four schools did not teach veterinary public health at all.
3. Nine schools have full-time professors for teaching public health courses, and 11 professors of public health have M.P.H. degrees. (Approximately 80 veterinarians in Latin America have M.P.H. degrees, including the 11 professors, and 60 per cent of the 80 work in the various ministries of health.) There were 5 veterinarians enrolled in 1963 for M.P.H. degrees.

III. *Course Description*

1. The teaching of veterinary public health (not including food hygiene, epidemiology and statistics) ranges from 8 hours to 102 hours in the 30 schools. These hours involve the teaching of administration, zoonoses, and environmental sanitation.
2. Veterinary public health courses are taught in 13 schools.
3. Statistics is taught in 4 schools (1 school gives 80 hours and 3 schools from 35-40 hours).
4. Environmental sanitation is taught in 2 schools.
5. The zoonoses course is taught in 1 school.
6. Food hygiene is described and taught as follows:

(a)	Food hygiene and bromatology	1 school
(b)	Meat and meat products	5 "
(c)	Milk and milk products	4 "
(d)	Milk and meat control	1 "
(e)	Bromatology	5 "
(f)	Diary science	2 "
(g)	Food control and legislation	1 "
(h)	Meat inspection	2 "
(i)	Milk laboratory	2 "
(j)	Milk technology and inspection	1 "
(k)	Meat technology and inspection	1 "
(l)	Inspection of food products of animal origin	1 "
(m)	Food control	1 "
(n)	Meat control	1 "
(o)	Animal food control	2 "
		30