

SCIENCE

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THE UNTILLED FIELDS OF PUBLIC HEALTH¹

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A SHORT time ago two Yale undergraduates came to my laboratory to consult me in regard to the choice of a career. One of them was a son of a public health administrator of the highest eminence; and they particularly wanted to know something about the field of public health, what it included, what was the nature of the work involved, what were the qualifications required, and what the financial rewards and the more intangible emoluments to be expected by those who might enter upon this career. I told them what I could of the current tendencies which to me seem to make public health one of the most stimulating and attractive openings lying before the college student of the present day; but I found that the answer to their question was by no means a simple one to formulate. The public health movement has been expanding so rapidly that what was "the New Public Health" fifteen years ago includes only the more conventional interests of the present day.

It seemed to me as I talked with these young men that we needed a formulation of current tendencies in the protean field of public health and an outline of the lines of future development so far as they can safely be forecast. It is essential that the worker in this domain of applied science should see clearly the goal toward which he is aiming, however far ahead of the immediate possibilities of the moment it may appear to be. Above all, it is desirable that we should have a definite and inspiring program to lay before the young men and women of the country who hesitate in the choice of a career. On every hand we hear the question, put by an eager young

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woman to the brilliant head of the instructive District Nursing Association of Boston, "Miss Beard, I want to go into public health. What it it?" It behooves us to answer this question; for the greatest of all needs in this field is undoubtedly the need of a personnel, larger in quantity, and better in quality, than that which has been available in the past.

For these reasons I have determined to devote my address as retiring chairman of the Section on Physiology and Experimental Medicine to a tentative, if necessarily imperfect, formulation of the scope and tendencies of the modern public health campaign.

I spoke of the public health movement as protean, and it is indeed true that the emphasis in this field has shifted with a rapidity almost phantasmagoric.

To a large section of the public, I fear that the health authorities are still best known as the people to whom one complains of unpleasant accumulations of rubbish in the back yard of a neighbor—accumulations which possess those offensive characteristics which somehow can only originate in a neighbor's yard and never in one's own. Sanitation, the maintenance of cleanly and healthful environmental conditions, does indeed represent the first stage in public health. When Sir John Simon initiated the modern public health movement in London three quarters of a century ago his primary task was the elimination of the masses of accumulated filth which kept alive the pestilences of the Middle Ages. When General Gorgas undertook the task of making safe and feasible the building of the Panama Canal he was in the same way confronted with problems that were primarily those of environmental sanitation. The removal of excretal wastes, the purification of sewage, the protection of water supplies and the elimination of conditions which permit the breeding of insect carriers of disease—these are always and everywhere the first tasks for the public health expert; and in the early phases of the public health movement in any country it is natural to visualize public health, primarily in terms of sanitation.

There is still much to do in this most fundamental branch of public health. That terrible

scourge of the Middle Ages, typhus fever, was only held in control during the war by a systematic and organized attempt to destroy the louse which carries the parasite of this disease; while the infection of bubonic plague, the black death of the Middle Ages, has been spread broadcast throughout the world during the past twenty-five years, and is held in check only by a vigorous campaign against the rats, ground squirrels, and other rodents which harbor the germ of this peculiar pestilence. The control of malaria, which takes a heavy toll of strength and vitality from the populations of our southern states and is estimated to cost the nation over \$100,000,000 a year, is one of the mightiest tasks which confronts the sanitarian, but a task which, as the demonstrations conducted by the International Health Board have made clear, is easily within the range of practical accomplishment, by systematic drainage and other measures taken against the mosquitoes which carry the germs of this disease. Malaria is with us always, but there are many maladies which like yellow fever arise from endemic foci in certain particular regions of the globe, and thence spread wherever the steamship and the railroad train can carry their inciting causes. Of recent years the bold idea has suggested itself of undertaking an offensive against these primary endemic foci of disease without waiting until the invaders cross our own national boundaries. In this way General Gorgas has carried the war against yellow fever into the enemy's own country at Guayaquil, and an organized campaign against such disease on a basis of world cooperation, perhaps through the agency of the International Red Cross, is full of promise of achievement in the future.

There is much then to be done in the field of environmental sanitation, yet as the public health movement progresses the tasks of sanitation in the narrow sense are gradually accomplished and therefore become relatively less important. Constant attention is of course required to maintain the environment in a healthful condition, but in most civilized communities, in temperate climates, environmental sanitation has become a matter of routine, and the pestilences spread by polluted

water and by insect carriers have ceased to figure as important factors in the death rate.

As the aims of sanitation are approximately realized in a given community, the attention of the health official turns from the water-borne and insect-borne diseases to the more subtle and more baffling maladies that are spread by direct contact from one individual to another. As typhoid, cholera, plague and typhus fever approach the vanishing point, measles, pneumonia and influenza become relatively more and more important. The control of community infections tends to replace the sanitation of the environment in the first rank of public health problems. The predominating tasks in this phase are tasks for the bacteriologist rather than for the engineer.

The leaders of the public health movement in the United States fifteen years ago were concerned primarily with problems of this sort. Their interest lay in the detection of incipient cases and of well carriers—those individuals who while in normal health themselves are cultivating and distributing from their bodies the germs of specific communicable diseases—in isolation, in bedside disinfection, in the breaking by any possible means of the vicious circle which transfers the discharges of the infected individual to the mouth or nose of the susceptible victim.

In the case of certain of the acute communicable infections we are fortunately able to invoke another weapon against our microbial enemies, by the prophylactic or therapeutic use of vaccines and immune sera, and so far the production of artificial immunity against attacks of the microbes of disease has proved on the whole more effective than our attempts at breaking the chain of contagion by isolation and disinfection. Smallpox, for example, has dwindled from the position of the chief pestilence menacing the human race to almost the condition of a medical curiosity, solely and directly as a result of the use of vaccine. Typhoid fever has been practically eliminated from the army by an analogous procedure. Antitoxic serum has placed the control of diphtheria within our grasp and diphtheria persists as a cause of death simply because of the failure to recog-

nize the disease with sufficient promptness and to apply the protective measures at our disposal.

In general this second or bacteriological phase of the public health movement, while it can boast such remarkable achievements as those to which reference has just been made, is still far from the complete success which has attended the applications of environmental sanitation. It may be stated with some confidence that there is not one of the diseases originating in the non-living environment which we do not know how to control and which it is not entirely practical to control, given adequate funds and personnel. Before some of the contact-borne diseases on the other hand we still stand almost helpless. We may be able to reduce the death rate from pneumonia by the use of protective vaccines, but there has been as yet no actual victory won sufficiently clear to admit of statistical demonstration. We can do much to mitigate the after effects of infant paralysis, but we have no effective method of controlling its spread. Before the ravages of a pandemic of influenza, such as swept the world in 1918, we are still practically without defense. Sanitarians have been accustomed to quote with horror the fact that bubonic plague killed 6,000,000 people in India during a period of ten years. Influenza carried off more than this number of persons in India in the four autumn months of 1918, and if this should happen again next year we should still be powerless to help.

There is much then to be done in the field of the community infections, many problems yet to be solved by the bacteriologist and serologist, before this group of diseases will pass under our control. Yet the suppression of community infections, like the sanitation of the environment, is but a part of the broad public health movement of the present day. The task of the health officer is to save lives, and to save as many lives as possible, by the intelligent application of the resources placed at his disposal. If he be wise he will direct his energies and his appropriations according to the indications derived from a study of vital statistics. He will apply his resources at a point where the greatest number of lives

can be saved with the least expenditure of effort. From this standpoint there are two aspects of the public health program which tend, and rightly tend, to overshadow all the rest, the campaigns against infant mortality and tuberculosis. These are the two lines of endeavor which promise the largest results in actual life saving; and in both these fields of effort the part played by sanitation and bacteriology in the narrow sense is a relatively small one. We can reduce infant mortality by the pasteurization of milk, by the elimination of flies, and by protecting the baby from contact with infected persons; but these are after all incidents in a broad program which involves the education of the mother in the whole technique of infant care, feeding, clothing, airing and bathing. What we are really aiming at is a reform in personal hygiene.

The campaign against tuberculosis offers another illustration of the same general principle. We can do something by providing a sanitary environment in which the worker is protected against vitiated air and harmful industrial dusts. We can do something by control of the careless consumptive and the consequent reduction of the menace of specific infection. Our main weapon against tuberculosis is, however, again, the weapon of personal hygiene. The principal machinery upon which we rely is designed to detect the early case and to impose upon the individual in the home or in the sanatorium a regimen of daily living that will make it possible for his own tissues to wage a winning fight against the invading microorganisms. Once more the problem is primarily a problem in the personal conduct of the individual life, and we see the teacher of personal hygiene emerging as a supremely important factor in the present-day campaign for public health.

According to the Director of the Census the five principal causes of death in the Registration Area of the United States for 1916, with the number of deaths caused by each were as follows:

Heart diseases	114,000
Tuberculosis	101,000
Pneumonia	98,000

Bright's disease	75,000
Cancer	58,000

Of these five causes of death there are two, pneumonia and tuberculosis, in which the sanitation of living and work places, the isolation of the infected individual, and in the case of pneumonia, the use of sera and vaccines do play an important part. Even with tuberculosis and pneumonia, however, education in personal hygiene fills a large place in the modern preventive campaign. Heart disease and nephritis may of course often be the end results of bacterial infections, but the immediate problem of their control is not to be sought along conventional sanitary and bacteriological lines. In the past they have indeed been considered as beyond the range of control measures of any kind. With these diseases too it seems clear, however, that education in personal hygiene offers large possibilities of effective results. If the weakness of the heart or arteries be known in time the adoption of proper rules for daily living can at least postpone the fatal result, if it can not effect organic cure.

It is for these reasons that the public health campaign of the present day has become pre-eminently an educational campaign. There are those who maintain that because the public health authority alone possesses the power to enforce regulations with the strong arm of the law such authorities should confine themselves to the exercise of police power, leaving educational activities to develop under the hands of private agencies. The actual amount of life-saving that can be accomplished by purely restrictive methods is, however, small, and such exercise of police power as may be necessary can only gain in effectiveness if it forms an integral part of a general campaign of leadership in hygienic living.

We have now added to the function of the sanitarian and the bacteriologist that of a new figure in the public health campaign, the teacher of personal hygiene; but we can not stop here if we are prepared to follow the courageous public health official in his determination to adopt whatever machinery may prove

necessary for the saving of a maximum number of lives at a minimum cost.

Education in personal hygiene is in part a general propaganda applicable to all alike. There are certain fundamental principles as to food, fresh air, exercise and rest, which every one should know in order to manage wisely the delicate physical machine entrusted to his charge. Unfortunately, however, each living machine is in some respects different from every other living machine, and in many cases deviations from the normal are so marked that they demand fundamental modifications in the regimen of daily life. The man with the weak heart needs less exercise, the man with weak lungs more air and more rest, the man with diabetes a special kind of food. In addition to the hygiene for the normal, which we may teach to all, there is a hygiene for the abnormal which requires an adaptation to each specific case. But it is obvious that the teaching of this kind of hygiene demands first of all an individual diagnosis. We are here face to face with the problem of the relation of the physician to the modern public health campaign.

In the past a sharp line was drawn between the measures taken by public health authorities to check the spread of epidemic disease and the daily routine of the practitioner in the treatment of the individual case. The first was public health, the second private medicine. With the passing of every year it becomes harder to draw such a sharp line, more difficult to say where public health should end and private medicine begin. The history of medical school inspection offers an excellent example of the tendency to obliterate such arbitrary lines. The physician was first sent into the schools in Boston in 1894 to perform a definite police function, to detect cases of communicable disease and by so doing to protect one child against the danger from another. If it had been proposed at that time to organize clinics for free treatment of disease among school children, the proposal would probably have been denounced as socialism of the most dangerous kind. Just so soon, however, as the physicians began actual work in the classroom they found that acute infections passing from

one individual to another played but a small part in the total burden of preventable disease borne by the children in the schools. They found defects of teeth, defects of vision, defects of hearing, enlarged glands. Nine tenths of the time of the school inspector of to-day is devoted to problems of this kind. He is no longer protecting one child against another. He is helping each child to attain its maximum possibilities of health and efficiency.

The discovery of non-contagious physical defects was the first step in bringing the public health movement into intimate contact with the individual child. Very soon, however, it became evident that the detection of remediable defects was of little value unless something was done to remedy them, and the school nurse was drafted into service to follow the child into the home and to persuade the parents to take the measures indicated by the medical examiner's report. The development of a school nursing service as an educational agency of this sort resulted in New York City in increasing the proportion of defects actually treated from 6 to 80 per cent. In a certain number of cases, however, a new difficulty arose. Remediable defects were present and the parents were willing and anxious to have them treated, but they were without funds to pay for the special medical care that was needed. The next step was as logical as the preceding ones. It involved the establishment of school clinics for the treatment of children unable to obtain the necessary care in any other way. So, with the establishment of nose and throat clinics, eye and ear clinics, dental clinics, for the school child the obliteration of the line between public health and private medicine was well-nigh complete.

If it is good public policy to provide for the school child whatever machinery is necessary to make possible the attainment of a reasonable standard of physical health, it is difficult to see why the same arguments do not apply to the adult as well. As a matter of fact exactly the same tendencies to provide (a) diagnosis, (b) hygienic advice, (c) treatment when necessary, are already manifest in our tuberculosis clinics and our venereal disease clinics, and are

beginning to develop in connection even with diseases of the heart and arteries and cancer. If it is sound economy to provide for the early diagnosis and sanatorium treatment of tuberculosis, it is just as sound to provide for the early diagnosis and surgical treatment of cancer. The two diseases are equally dangerous, and equally burdensome to the community; they are equally preventable, if the right educational and clinical procedures are organized for their control.

From both sides of the artificial boundary line between public health and private medicine comes the appeal for a closer correlation. The public health worker needs the physician because in so many diseases education depends on diagnosis and demands the application of medical skill. The far-sighted physician is equally eager to link up his science with the public health program, because on his side he realizes that medicine can never attain its full potentialities of service unless it is made really preventive through some type of effective professional and social coordination. It is a striking fact that in spite of the great advances in medical science diseases like heart disease and nephritis and cancer, which have been handled in the past along strictly medical lines, have shown no decrease comparable to that which has been manifested in the group of maladies with which the sanitarian has dealt. This is not because medical science is helpless but it is because medical knowledge has generally been applied only when disease has gone so far that the damage is irremediable. Medical knowledge will be highly effective only when applied in the incipient stages of disease. When this comes to pass "preventive medicine" will become a reality and not merely a catch word.

It is not for us to say to-day in just what fashion the reorganization of medical service which will make it effective for prevention can best be brought about. In the working out of such a scheme there must be first of all, within the profession itself, effective coordination of specialties in clinical and laboratory lines to provide the type of expert service which is furnished by our best hospitals and which no in-

dividual private practitioner can possibly supply. In the second place such organized medical care must be made available not merely for the very poor and very rich but for the entire community, for those who can afford to pay the whole or a part of the cost of the service they require, and for those who can not pay at all. Finally, if medical care is to be made really preventive in its application its cost must be so distributed as to encourage systematic recourse to the physician as an agent for the detection and control of incipient disease, rather than as a last resort when illness has become too grievous to be borne.

There are those who believe that these ends may be attained through group medicine and it is interesting to notice that very similar ends have actually been reached in the nursing field through private initiative as manifested in our best visiting nurse organizations. There are others who claim that medical and nursing service can best be provided in connection with a plan for sickness insurance and there are still others who urge that the insurance problem should be handled as a distinct and separate one, and that the early diagnosis and preventive care of incipient disease should be attained through a definite system of state medicine.

The working out of the best plan for securing such ends as these is a fascinating task for the publicist of the future, and it is quite possible that the problem may be solved in true Anglo-Saxon fashion by no single logical procedure but by diverse methods, suited to local ends and local circumstances. The remarkable developments during the past ten years in the field of industrial medicine may have a wide bearing on the general solution of our problem as a whole. Some 900 different industrial establishments employ at this time 1,500 industrial physicians, and the plant hospitals under their charge, from first-aid dressing stations, are developing into educational centers and diagnostic clinics and laboratories for the study of industrial physiology and vocational guidance and rehabilitation.

We have seen the emphasis of the public-health campaign move steadily inward from

the environment to the individual. The primary interest of the health officer has been transferred from the swamp and the dung heap to the control of infections and thence to the detection of non-contagious physical defects and the hygienic guidance of the individual living machine.

In the development of the public health campaign to the realization of its fullest opportunities there is taking place to-day a swing of the pendulum backward to a new interest in the environment, but an environment of a nature very different from the simple environment with which Simon dealt. General Gorgas at Panama fully grasped the significance of the wider and more subtle environment which most of us are just beginning to glimpse as an essential problem in the public health campaign. He eliminated yellow fever and malaria by the drainage of marsh lands, but he attempted to deal with pneumonia by raising the wages of the employees upon the Isthmus, for he realized that in the case of this and many other diseases the most effective weapon at our disposal is the building up of general vital resistance, which depends upon the maintenance of a satisfactory social and economic level.

Dr. Emmett Holt has said that there are two causes of infant mortality—poverty and ignorance. In the infant welfare movement, the anti-tuberculosis campaign and every other field of public health, we come sooner or later to a realization of the fact that education and medical and nursing service, while they can accomplish much, can not cope successfully with the evil effects of standards of living too low to permit the maintenance of normal physical health.

As I have elsewhere pointed out, in the Johnstown survey, Miss Duke tells us that the infant mortality in one ward was 271 deaths per 1,000 births against 134 for the city as a whole and 50 for the ward which showed the lowest rate and the explanation is that "this is where the poorest, most lowly persons of the community live—families of men employed to do the unskilled work in the steel mills and the mines." Dr. Sydenstricker and his associates

in the U. S. Public Health Service in a report on the relation between disabling sickness and family income among cotton mill operatives in South Carolina find that a monthly income equivalent to less than \$12 per person (on an adult male unit basis) the sick rate was 70.1 per 1,000; with an income between \$12 and \$14 it was 48.2 per 1,000; with an income between \$16 and \$20 it was 34.4, and with an income of \$20 and over it was 18.5.

We can conclude from these figures and from many similar investigations that poverty and sickness are closely correlated. We can not conclude that the poverty is responsible for the excess of sickness. In some instances the relation of cause and effect may be reversed. In other cases both poverty and disease may be due to underlying inheritance. People do not usually live in the poorest quarters of a city or work at its underpaid employments by choice or by accident. In general, and on the average, we shall find in such districts and such employments a concentration of tuberculous stock, of alcoholic stock, of feeble-minded stock—poor protoplasm and a bad environment supplementing each other in a vicious circle.

No one can perhaps tell just how far poverty in such cases is the real and effective cause of the failure to achieve and maintain a normal standard of physical health. It is clear, however, that there is a certain standard of income below which the maintenance of health is impossible; and it seems reasonably sure from the studies of Royal Meeker, of the U. S. Bureau of Labor Statistics, that a certain not inconsiderable proportion of the population of the United States has to-day a family income below that figure.

If an initially normal family can not gain a livelihood adequate for its minimum physical needs, there is evidently a problem of social readjustments which our nation must face as a fundamental of post-war reconstruction; but what shall we say of the family which on account of inherent physical or mental defects is unable to reach a minimum level under a wholly fair and equitable basis of compensation? There are but two alternatives as I can see it; since the moral sense

of mankind repudiates the rigorous application of the principle of unhindered natural selection. We can let the combination of defective protoplasm and crippling environment accomplish the major portion of its work and then salvage what we can from the wreck by some form of institutional relief. Or we can apply our social energy and our community funds to make good the deficiencies in the beginning. I have little doubt as to which will be found in the long run the cheaper way, and I am quite certain that the preventive method will prove more conducive to a high national morale.

If the foregoing outline of the problems of public health be accepted as correct, it will be obvious that the field as thus visualized is no small and restricted one. The claim to so large a province will be denied by many, within, as well as without, the public health profession. The logic of the situation and the tendencies of social development are, however, sweeping the public health movement forward to a future of wider possibilities than those dreamed of by its own protagonists. If we are looking to the future we must conceive our subject in terms no smaller than those of the following definition:

Public health is the science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing service for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health.

Public health conceived in these terms will be something vastly different from the exercise of the purely police power which has been its principal manifestation in the past.

Even to-day it is still possible to make an effective argument for increasing health department budgets by showing that appropriations for the protection of health are in most cities far less than those which are made for

police and fire protection, matters of far less moment in actual possibilities of community service. As a matter of fact the police department and the fire department furnish criteria much too modest for the public health department of the future. It is rather to education that the possibilities of public health should be compared. I look to see our health departments in the coming years organizing diverse forms of sanitary and medical and nursing and social service in such fashion as to enable every citizen to realize his birthright of health and longevity. I look to see health centers, local district foci for the coordination of every form of health activity, scattered through our cities, as numerous as the school houses of today and as lavishly equipped; while the public health services of the city and state will constitute a corps of experts comparable in size and influence to the great educational organizations of the present day.

In the development of the public health campaign of the future along such lines as these it is obvious that many different experts, of fundamentally distinct training, must contribute their special resources to the common task. Ignoring all minor specialties there must be at least the following seven types of highly qualified persons in this field:

The physician	The epidemiologist
The nurse	The engineer
The bacteriologist	The statistician
The social worker	

In addition there must be inspectors to supervise sanitary conditions, housing conditions, food stores and the like, for whom no special training is provided anywhere in this country, but who should be offered brief practical courses to fit them for the relatively modest duties which their task entails. Finally there is the administrator who organizes and develops the work of all the rest.

The physician in the public health field practises medicine but with a difference, in that the goal before his eyes is prevention as well as cure, and that he has always in view not merely the individual but the community as well. In the infant welfare station and the school clinic and the tuberculosis dispensary he visualizes not merely the individual

case but its family environment and its physical background. He is constantly striving to find the incipient causes of disease and to deal with those causes before they reach their deadly fruition. He must be much more than a physician in order to fulfil this task; for he must have a knowledge of bacteriology and sanitation, of health administration and statistics, above all of social relationships and social machinery which the curriculum of even the best medical schools can not attempt to supply.

So the public health nurse must be a trained nurse skilled in the relief of suffering and the bedside care of the sick, but she must be much more. Her work is primarily that of the health teacher, the messenger who carries into the home and interprets to the individual mother the gospel of good health. She must work largely alone, not under the immediate direction of a physician. She must know her bacteriology and her physiology, her sanitation and hygiene, well enough to teach their principles to others; and she too must deal with the individual, not merely as an individual, but as an element in a complex social group.

The bacteriologist in the laboratory and the epidemiologist in the field are two more of the specialists needed, whose work is concerned primarily with the war against the community infections. The former offers aids in early diagnosis and prepares sera and vaccines for the prophylactic and therapeutic treatment of these diseases; the latter by his detective work makes it possible to trace out the subtle pathways of infection by which they spread from one person to another through the complex web of community life.

The public health or sanitary engineer is again an engineer *plus*. He must have mastered the underlying sciences of physics and chemistry, of structures and hydraulics, and he must also be familiar with the technical applications of his art to the particular problems of sewage disposal and water supply, ventilation, illumination and the like.

The statistician correlates and analyzes the records of births, deaths and illnesses, keeping an expert finger as it were on the pulse of

the nation's health. His work is the book-keeping of public health, indicating the lines of profitable expansion and furnishing us with the credit balance of lives saved to the community as a result of various public health endeavors.

In the case of each of these experts, and in the case of the social worker who is operating in the field of public health, there is required sound elementary education in some fundamental branch of science with the addition of specific training in its applications to the field of public health. For the nurse who desires to become a public health nurse there are offered four-month and eight-month courses of special training in public health nursing. The physician who desires to become a public health physician, the engineer who desires to become a sanitarian, the bacteriologist who desires to become a public health bacteriologist, the social worker who desires to apply a fundamental knowledge of the principles of social readjustment within the field of public health, must similarly undergo a special training, if their services are to be made promptly and fully available. It is for this purpose that our leading universities and technical schools offer the Certificate in Public Health, which like the Master's degree is the equivalent of a year's graduate study. The C.P.H. course gives to the medical graduate the special training needed to equip him for the application of medicine in the field of public health, and in the same way enables men and women who have had college training in the fundamentals of bacteriology, engineering, sociology or statistics to fit into their special places in the general scheme of health protection.

To turn from these special phases of the public health campaign to the organization of the movement as a whole, it seems probable that the ideal public health administrator of the future will be the man or woman who has been first medically trained and has then specialized in a school of public health. If I am right in my belief that the public health movement of the future will go far in the direction of including medical and nursing service within its ample bounds, it is clear

that a man who has both a medical and a public health training will possess peculiar advantages as an administrator. It is for this reason that the principal eastern universities offer the highest degree in this field, the Doctor of Public Health, only to medical graduates and require that it be earned by a rigorous course of two years of academic study.

It will be long, however, before the supply of doctors of public health is nearly adequate to the demand, and for some time to come administrative positions, as well as laboratory and statistical positions, and those concerned with social reorganization, will be open to the college man or woman of marked ability who devotes a single graduate year to study for the Certificate in Public Health.

It can be said with very literal truth of the field of public health to-day that the harvest is ready and that the laborers are few. On all hands there comes to us the call for bacteriologists and statisticians, for industrial physicians and school physicians, for public health nurses, and for health officers. The American Red Cross is inaugurating a nation-wide campaign for the development of health centers throughout the country. Each one of the thousands of health centers to be started under this plan will call for an expert personnel which does not exist at present. The state of Ohio has just conducted a civil service examination for a list of candidates for 110 positions as full-time health officers within that state, at salaries ranging from \$2,000 to \$6,000 a year, with permanent appointment under the civil service law; and it was necessary for the state to organize a special course of instruction in order to have anything like the number of fairly qualified candidates for the responsible positions within its gift.

The science and the art of public health have progressed to a point where they can render to the public a service to be measured in the saving of hundreds of thousands of lives in this country every year. Public authorities and private agencies from one end of the land to another are realizing these possibilities of service and are ready to provide the necessary

funds and to give the necessary powers to properly qualified experts. The lack in the whole scheme of things at the present moment is the lack of personnel. As a prominent official of the Rockefeller Foundation said to me the other night, "The way they are appropriating money for public health in the southern states frightens me, because we haven't the men to send to them to help them spend it wisely."

We stand, I believe, at the beginning of a new phase of human history, a phase in which the physical and mental health and efficiency of the human being will be transformed by science as the physical background of civilization has been transformed in the past half century. In the name of the need that confronts us for the personnel to carry on this work I believe we have the right to say boldly to the college men and women of America that we need them in this great business. We can promise to the college graduate, whether his leanings be toward work in the laboratory, toward sanitation in the field, toward the tasks of social propaganda and social reconstruction—we can promise to the medical student, and we can promise to the graduate nurse—that each and all of them will find in the public health movement of the future careers which will compare favorably in security and in material rewards with the average return which is won by the college and medical graduate in other fields. Above all we can promise the opportunity of a kind of service which brings a satisfaction deeper than any material reward.

There are great unsolved problems waiting for the Pasteurs of the future. Influenza, pneumonia, cancer and the rest of the unconquered plagues will some day yield to the patient assault of science, and it may well fall to the lot of young men who are entering our laboratories to-day to write the obituary of these diseases as Walter Reed did that of yellow fever in 1900. Two of Reed's letters to his wife after he and his associates had made the great discovery that ensured the conquest of yellow fever in the ensuing year, are so full of the solemn dignity of such a victory that I will quote them.

Six months ago, when we landed on this island, absolutely nothing was known concerning the propagation and spread of yellow fever—it was all an unfathomable mystery—but to-day the curtain has been drawn.

And later on New Year's Eve, he wrote:

Only ten minutes of the old century remain. Here have I been sitting, reading that most wonderful book, "La Roche on Yellow Fever," written in 1853. Forty-seven years later it has been permitted to me and my assistants to lift the impenetrable veil that has surrounded the causation of this most wonderful, dreadful pest of humanity and to put it on a rational and scientific basis. I thank God that this has been accomplished during the latter days of the old century. May its cure be brought out in the early days of the new.

Yet we need not wait for any of the great discoveries of the future to make the public health campaign of the present day bear fruit. We want sanitary statesmen as much as investigators. We need organizers and propagandists for the cause of health, capable of building wisely the great scheme of health protection of the future and of enlisting in its support the enthusiastic cooperation of the peoples of the earth. To the administrator, as much as to the investigator comes the consciousness of a reward for his labors, fuller and more immediate than that which can be earned in many walks of life, for he can know that in a given city in a given year so many hundreds or thousands of men and women and children are alive and well who would have been in their graves except for him. What old Sir John Simon said of industrial diseases is true of every kind of preventable malady which afflicts mankind.

The canker of . . . disease gnaws at the very root of our national strength. The sufferers are not few or insignificant. They are the bread winners for at least a third part of our population. . . . That they have causes of disease indolently left to blight them amid their toil . . . is surely an intolerable wrong. And to be able to redress that wrong is perhaps among the greatest opportunities for good which human institutions can afford.

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THE ORGANIZATION OF RESEARCH¹

THIS is an age of organization. Almost within the lifetime of some of us the industries, with the exception of agriculture, have passed in large degree from the individualistic to the corporate form. Combinations not merely of national but of international scope exercise a large measure of control over manufacturing and commercial activities, while associations of the greatest variety—commercial, charitable, reformatory, labor—have multiplied until their name is "legion." Almost every conceivable calling, from the midwife's to the undertaker's, is organized.

Since science is a product of human activity its methods must necessarily be influenced by the spirit of the time. In particular, the successes of groups of scientific men in making important contributions to the solution of the technical problems raised by the entry of the United States into the world war has led to an emphasis upon the advantages of organization and cooperation in research which was very much in evidence at the last meeting of this association. This was particularly evident, perhaps among the biologists where it was, in the words of another, "the dominant note," but the same note has been sounded by various prominent writers both before and since that meeting. It seems desirable, therefore, in view of this apparently strong trend of both public and scientific opinion, to inquire somewhat carefully into the extent to which it is justified and as to the probability that a more complete organization of research will enable it to render more efficient public service. In attempting to do so I shall, of course, have reference particularly to agricultural research—implicitly if not explicitly.

In the early history of science, research was necessarily upon an almost purely individualistic basis. Men of genius here and there were laying the foundations of the present amazing superstructure not only without

¹ Address of the vice-president and chairman of Section M—Agriculture, American Association for the Advancement of Science, St. Louis, December, 1919.