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THE CONTROL OF DISEASE*

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Mr. President, I appreciate very highly the honour which the Council of your College has done me in inviting me to deliver this the first Frederick Price Lecture. I have enjoyed the personal friendship of the Founder of the Lecture for the past thirty years, but I know his mental integrity to be such that he would never suggest my name to the Council on this account. That both he and the Council have generously thought that they saw other reasons for their choice fills me with a sense of pride and gratitude, not unmixed with anxiety. I know the present College benefactor well enough to say that he desires intensely that this lectureship shall, during the years that are to come, be the means of advancing the principles and practice of Medicine, a cause to which he has devoted his life ever since he left his alma mater here in Edinburgh. He had been a pupil of Grainger Stewart, John Wyllie, Greenfield, Thomas Fraser, Byrom Bramwell, George Gibson, James Affleck, and Robert Muir. I have often heard him say, what must be obvious to all of us, that the teaching of Medicine which he enjoyed was superb. If the contributions made by successive lecturers to this cause approximate to the standard which the founder has himself set for those of us who have from time to time collaborated with him, then I feel confident that the prestige of this College will, through this new foundation, be fully maintained.

I

The field covered by the title which I have chosen for this lecture is so enormous that I shall anticipate criticism which might otherwise be made in respect of omissions by saying that I propose a general survey of the present position rather than a detailed analysis of my subject.

First of all, let me define it. I shall understand by the Control of Disease the "effective resistance of agencies the operation of which would otherwise militate against the enjoyment of an optimum span of life." As it seems to me, we have to-day arrived in this matter at that stage when, to borrow a simile that is topical, the forces of disease control are manœuvring for allies which will complete, or at any rate considerably strengthen, their collective security. The collective security of man for man, in the protection of his health against aggression by disease, is the main theme of my lecture. As yet the aggressors are not held by superior forces, but the history of disease control seems to show a gradual strengthening of these forces and the hope of an ultimate checkmate.

It would be interesting to try to forecast how, and when, if ever, control will be absolute and security will

be complete. Before indulging in such speculations, however, I propose to notice, at this point in our development, which are the laggard states and where are the enemy's allies.

Even though I shall do no more by way of historical survey than to trace briefly the stages, or steps, that man has taken towards this end, it is to be observed that here, as in so many of his activities, we cannot ignore the implications of the past if we are to deal adequately and faithfully with the present and the future. The present and the future are largely conditioned by the past, so that to wind the film of time back and try to evaluate the trends and achievements of even the past fifty years in Preventive Medicine would be no waste of time. It cannot be too often stressed that there is no start *de novo* either for Science or for Man. There are lessons to learn much further back than this, though here we can only glance at some of them.

Dawn of Disease Control

If we look back to the dawn of human history we find our remote ancestors battling their way to survival with very rudimentary weapons. Disease control was first of all a matter of first aid, and instinctive and desperate at that. The story of the first efforts made by the small social unit called the tribe in this direction has been told so often and so well that it needs no retelling, but some of us still underestimate the achievements of the earliest civilizations in this sphere. To the nomads life was a kind of running fight against the major calamities, but the study of food production and sanitation as vital parts of the pattern of life of groups, of cities, and of States has a much longer history than many of us realize. In other words, the story of Preventive Medicine began long before Greece and Rome, for these societies are relatively modern when compared with those of Sumeria and Egypt. Public Health had begun with the building of brick drains nearly 2,000 years B.C., and even 3,000 B.C. some form of Public Hygiene existed amongst the pre-Aryans in India. But through all these centuries human life remained cheap and Medicine rudimentary and superstitious. The position therefore remained static, or advanced very little, and very irregularly, only to recede again.

To the Greeks we owe that tremendous advance the introduction of the Hippocratic method—better known as Clinical Medicine. This is a contribution the importance of which cannot be overestimated. Without accurate observations of the signs of disease and accurate records of the course they run, a system of control could not begin to exist. To Rome we owe the birth of the civic sense, the forerunner of what has, through the generations,

* The first Frederick Price Lecture, delivered before the Royal College of Physicians of Edinburgh on May 15.

developed into municipal government and the "local authority," a corporate body that has become an essential feature in our Health Services. With their genius for colonization abroad the Romans exercised wholesome control at home, and both of these processes were of great value in checking disease.

So long as slave labour was abundant so long the human unit remained of little consequence and Medicine remained the prerogative of the rich. But the "health of the few cannot be assured in a community which allows disease amongst the many," and so the few soon found that if they wished to keep themselves even relatively immune they must organize, in some degree at any rate, the lives of the many. Such organization formed the beginnings of disease control, or Preventive Medicine as we now know it.

Influence of Religion

During the first centuries that followed upon the decay of the Graeco-Roman civilizations, even though Science was marking time or being buried under the lumber of faiths and fears, quackeries and dogmas, Christianity was getting its spiritual and material hold upon the peoples of Europe. This fact led directly to an appreciation of the value of the human unit, and in terms of disease control nothing could be of greater significance than this. The body was the temple of the soul, and therefore, though the mystics scorned it and were even ashamed of it (a minority view which is dimly reflected in certain cults even to-day), in the general view of the Church it was for this reason worth preserving. In Western Europe Medicine was fostered by the monastic foundations, and the medical schools of purely ecclesiastical universities. For the first time the economics of living received attention; the struggle against hunger became linked with the struggle against disease. This link has become more and more intimate, and is now inescapable: agriculture and horticulture—biotechnology in fact—can never again be separated from the progress of Medicine.

Finally, in this particular sequence, comes the great advance made by the establishment of hospitals, the first coherent effort at disease control. Hospitals were a direct outcome of the Christianization of Europe: the care of the sick poor, whether from the growing motive of brotherly kindness or for the glory of God or, as was, and is, not infrequently, the case, simply for the salvation of the soul of the benefactor. Sufferings which had hitherto been deemed the act of God or of the Devil, and so unavoidable, were combated by a continuous and organized warfare.

Public Hygiene

About the middle of the fourteenth century it was first appreciated that insanitary conditions were associated with the spread of contagious diseases. In the time of Edward III, for example, the City of London was admonished in a Royal Order about "fumes and abominable stench" resulting from the failure to control the disposal of refuse. Meantime, diseases like Leprosy, from their very terror, impelled to measures of control, oftentimes of heartless severity, and the responsibility and risk of these measures naturally fell to the physician, who began to earn the reputation of protector, or Health-man, a function which has gone on increasing through the centuries. His prestige in this direction rose at the same time as the religious background of his professional work fell away, as it did fall away during those turbulent years when the Reformation and the Renaissance led men to question the superstitions which had for so long

obscured the clarity of the Greeks, whose methods were based solely upon careful observations. In short, Medicine freed itself from Religion just as Science did, and disease control gained considerably by the process.

The Great Plague epidemics gave a fresh stimulus to measures of Public Hygiene. Among these were the first quarantine orders issued in 1663. Incidentally the Great Fire, that "most drastic of all sanitary reformers," was a quite involuntary effort in the same direction. That there was a growing consciousness of the importance of disease control about this time is shown by the interest taken in what we now call Vital Statistics. Bills of Mortality were introduced, and these concerned themselves with the health, as well as with the taxable value, of the population. The rudimentary elements of Life Insurance, appearing about the same time, indicated again that life and health were beginning to attract notice for their own sake.

On the civic side in this seventeenth century the factors of disease control began slowly to mobilize. The Government, too, recognized the necessity for liaison with an organization of experts, and we trace to these times the accelerating power of war (or fear of war) on the sciences that bear upon health. The "Invisible College," which was the embryo of the Royal Society, and the new foundation of the Royal College of Physicians, assisted in implementing this urge towards organizing against disease in addition to organizing for progress in the art and science of life. In 1665 the Royal Society issued its famous "Heads of Enquiries," an effort towards a scientifically planned food production. Persons skilled in husbandry were invited to impart their knowledge for the common benefit of the country. Hogben quotes Lennard as saying that this was "a brave attempt to link up book learning and scientific research with the experience of practical farmers." That was nearly 300 years ago. To-day we have the science and the experience, but we still lack the planning.

Reawakening of Medicine

I must not stay to deal adequately with those amazing one hundred years covered by the second half of the seventeenth and the first half of the eighteenth centuries. The tempo quickened, and Medicine and Science came awake again. The intellectual and scientific excitement of these times, with the astounding vitality of the will to discovery, must have been tremendous. Hippocrates had been separated from the world of Medicine by the Dark Ages, but now from the springboard of the Renaissance and from the genius of Leonardo and Vesalius there arose, during these virile years, Harvey and Morgagni. The race to a greater understanding of the machinery of the human body began. Giants like Sydenham and Hunter, pioneers in Clinical Medicine and in Pathology, were urged to accelerate the pace by the crying needs for more and more knowledge.

Regional and Occupational Diseases pressed for attention. With a new conception of the worth of the human unit to Society came the need to alleviate the sufferings of persons hitherto regarded individually as of little importance—soldiers and sailors and the rank and file of the nation. In the prevention of scurvy, to take only one example, the science of vitamins saw its birth. The French Revolution and the new humanity born of its pangs contributed not a little to the drive towards cleansing the body social of its grosser invitations to disease; and the humanitarian, the social reformer, and the scientific researcher were at last properly lined up. The abolition of gaol fever was the result of this new team-work.

But exciting though all this groundwork was, the control of disease awaited the acquisition of new tools for its really effective advance. This came with Leeuwenhoek's discovery of the microscope in 1683, "letting science in" upon a whole new world in which resided the already suspected, but till then unseen, essential causes of the infectious diseases. The solution of the problems of biotechnology lay open for man's exploitation. All this paved the way for Pasteur, as the result of whose genius and labours the Aristotelian doctrine in its bearing upon disease at long last died.

The Accelerating Influence of War

I spoke of war as an accelerating influence. Twice was this strikingly demonstrated. The Crimea provided the background on which the work of Pasteur was tested on the large scale. Not only so, but there, too, military hygiene and sanitation were revolutionized by the human efforts of Florence Nightingale. It needed the war of 1870 to concentrate attention upon the horrors of surgical methods and results. "He who conquers purulent infection deserves a golden statue," exclaimed the great Nélaton in sheer despair at the sight of the victims in hospital during the siege of Paris. In the history of disease control the statue has been raised jointly to Pasteur and Lister.

During and just after a war clinical material comes before us not in single file but in battalions. This was so in the Boer War, which gave us a unique opportunity of testing Wright's anti-typhoid serum. It was so in the Great War, when shell-shock and allied mental states gave a fillip to psychotherapy. The technique of blood transfusion was greatly improved and methods of therapy in severe sepsis became established.

Such happenings do not provide a defence of war: there is no defence for war: war is always dysgenic, destroying the most fit and leaving the most unfit: and though one or two steps may be taken forward by Medicine, a hundred steps that might be taken forward are halted, it may be for many years. All that these things show is the fortuitous element in human progress. If war should come again, war having the dimensions that a large-scale modern war must inevitably have, there is nothing by way of a principle in disease control, analogous to these benefits, that can readily be thought of as accruing from it. And yet if there accrued the recognition of a brotherhood amongst men this would, I suppose, be the greatest benefit of all.

Advances Made During the Past Century

That the control of disease has made great strides during the past century, and especially during the latter half of it, is a truism. Whether we consider prophylaxis or treatment the advance has been on lines of geometrical, as against arithmetical, progression when compared with any similar period in man's history. This is the result of the extended front to which I have referred. Physicians, surgeons, chemists, physiologists, bacteriologists, physicists, geneticists, psychologists, and statesmen—all have made their contributions, and some of the most striking of these have been due to co-ordinated research between two or more experts trained in different fields. The front has become deeper as well as longer.

In prophylaxis the tracking down of the intermediate hosts made use of by the malarial and other parasites, and the measures taken to suppress them, have added a brilliant chapter to Preventive Medicine. The names of Laveran, Manson, Ross, Gorgas, and MacCallum are conspicuous in this field. Immunology, introduced in its

single example by Jenner, became a science under Behring and Kitasato, with their preparation and standardization of specific antitoxins for the treatment and prevention of diphtheria and tetanus.

Chemotherapy, a very ancient but empirical method of control, receiving from time to time valuable aid from the chemist by the isolation of active therapeutic principles from crude drugs, and by the preparation synthetically of these same principles and of equally useful modifications of them—chemotherapy took on a rational form under Ehrlich. The demonstration that a definite chemical affinity existed between the constitution of a drug and its action in the body led Ehrlich to seek for some substance which, injected into the blood stream, should act as a universal sterilizing agent. His ambition was not realized, but in the pursuit of it he not only added enormously to our power of controlling syphilis, he gave a forcible stimulus to chemotherapy, which has resulted, even during the past few years, in the addition of a series of compounds of the greatest service to our pharmacopoeia.

Chemotherapy v. Immunology

A friendly rivalry has for a long time existed between these two last-named therapeutic methods. Alternately, the chemotherapist and the immunologist has held the field. The most recent score, and a very high one, is with the chemist. I refer to the introduction of the sulphonamide compounds and their success in the treatment of certain acute coccal and bacillary infections. Although the first azo-dyes containing the sulphonamide group were isolated as long ago as 1908 they were only tested clinically in the years 1933 to 1935. In the latter of these years a German worker named Domagk found that the compound called prontosil was effective against a lethal dose of haemolytic streptococci injected into the peritoneum of the mouse. Intensive study of this and allied substances, both in animals and in man, quickly followed. Chemists, experimental pathologists, and clinicians all took part, and a flood of communications on the subject rapidly appeared. Already these compounds have made good in many forms of highly pathogenic coccal infections, such as erysipelas, puerperal fever, pneumococcal, gonococcal, and meningococcal diseases, and also in certain coliform diseases. The field is by no means yet fully explored, but we may even now confidently affirm that the early promise of success for these new drugs is more than justified. The effective blood content of the active substances is being ascertained and the indications and contraindications are becoming widely known. Since the brilliant work of Ehrlich and his pupils thirty years ago there has been no chapter in chemotherapy to equal this. The rapidity with which this new therapeutic measure has become an established practice, and the degree of control that is possible, illustrate in striking fashion the power of modern Medicine to add effectively and rapidly to the physician's armamentarium.

No wonder the pendulum has recently swung far in the direction of a preference for using the new type of remedy to the exclusion of the old. This does but illustrate a common weakness inherent in human nature. Sera and blood antiseptics are not mutually exclusive, they are supplementary the one to the other. Even so, the specificity of antitoxins and other immunological measures in the prophylactic and curative treatment of diphtheria and tetanus remains unchallenged, and we shall doubtless see the pendulum swing again when once more the limits of chemotherapy seem for a time to be reached.

The Viruses

The last of the known microbic causes of disease to resist our efforts at control are the viruses, and this statement applies equally to preventive and to curative measures. Evidence is already convincing that this group of infective agents is responsible for such important diseases as the common cold, influenza, measles, encephalitis, and poliomyelitis. In the case of two other virus diseases—small-pox and rabies—principles of control have for a long time been established, in the former by vaccination and in the latter by the systematic muzzling of dogs.

Concerning cancer there is much more debate, but the hypothesis that this disease is also due to elementary particles of virus nature, colonizing inside the cancer cell and possessing the characters of a very strict parasite, would explain most, if not all, of the facts at present known to us. Control still lags in regard to this particular scourge, but many of us believe that, the concentrated attack that is now being made upon it is likely to achieve results in the near future. Whether we shall attain control before we have established the cause, or not, it is impossible to say. Meantime, in addition to continuing research into causes it is improbable that we have yet reached the limits of therapy by radium and x rays, and in certain situations such as the stomach and bowels effective surgery, which alone at present makes recovery possible, depends upon early and accurate diagnosis.

The phenomenal success that followed the discovery of the sulphonamide group of drugs in their application to infections due to certain bacteria of the coccal and bacillary type led very naturally to their use in a number of virus diseases, but with disappointing results. Some tempting results have, however, been claimed by a few workers in influenza, the common cold, distemper in dogs, and trachoma, and these results do not, in the judgment of G. M. Findlay, who has studied the literature very thoroughly, appear to be merely due to the effect of the remedies upon the secondary bacterial infections which so frequently complicate virus diseases. It seems clear, however, that, taking the virus group as a whole, its control by chemotherapy, whether in its prophylactic or in its curative action, is a matter for future research.

In the meantime some degree of prophylaxis in certain of the virus diseases has been achieved by the use of serum from convalescent patients, and in the case of measles this form of control has passed the experimental stage and has become of definite practical value. The Ministry of Health keeps a pool of anti-measles serum the efficacy of which in inducing passive immunity is undoubted. The same method of therapy has been used extensively in poliomyelitis, though with less convincing results. The principle illustrates the ever-extending front of disease control, and is another example of co-operation by the public in its own interest—a veritable and unchallenged instance of true communism. It is to be hoped, though not for this reason alone, that the principle may be found of greater service in the future.

II

The Machinery of Control

The machinery by which the control of disease is undertaken up to the limits of our present knowledge has become more and more elaborate or, to use another simile, the battle front has become more and more extended. To the doctor, making that personal and all-important contact with the individual citizen which is the spearhead of the

attack, there has been added the medical officer of health, who implements the powers of the local authority acting on behalf of the Ministry. For the past twenty years there has also been added an international clearing-house in health matters, resident in the League of Nations, an organization which has grown as much in value and prestige hygienically as it has dwindled politically. Pathetically, the health activities of the League remain as a rock, whilst the swirling passions of international politics surge around it, washing away the very foundations of that amity of nations for which the League was constructed. Let us hope that this rock will prove a base upon which another and permanent League of good will and honest endeavour may be built.

The front does not end here. Potentially of extreme importance, we now see a slowly increasing body of Health Education supplementing these elements. We also see Woman becoming a vital factor in the fight for Health. Then there is to be noted the contribution made through Industry. And lastly there is the citizen himself, without whose voluntary co-operation the battle front will always be vulnerable. It is necessary to examine some of these sectors opposed to the enemy a little more closely.

1. The Citizen

Let me begin with the citizen, the individual unit for whose welfare all this machinery exists. He has not only a natural lust for a healthy life of the body, he has also a lust to find out what is valid in the life of the spirit. But we must not forget that before either of these things stirs him he has certain basic needs that demand satisfaction and without which he cannot be actively interested in Health, either personal or public—enough of the right food, decent shelter and clothing, a job of work with opportunity for play and access to sunshine and fresh air. Simple things these, but things without which Health and Happiness are a mirage which the most devoted and diligent doctor or medical officer of health cannot bring to earth.

At this point the control of disease conflicts with Economics. To preach Health to the underfed or overcrowded is a hypocrisy, and so long as there are millions of citizens living below the poverty line so long will the practical control of disease lag behind. True, there are also millions of folk above the poverty line who are not using the means of defence that are available to them. For these the primitive lust of which I spoke must be transmuted into a passion and a purpose, which is the aim of Education if taken in its truest sense. But an ideal Health Service should be so constructed that the citizen has no excuse not to be healthy, and in order to achieve this consummation the "link-up" of Medicine with Economics becomes imperative. Such a "link-up" has not yet been attempted in this country. There has been much talk about nutrition, but as yet there has been no effort at a long-view policy which will help to implement recent knowledge on the subject in terms of improved national health. It is surely the duty of the doctor to stress the importance of such a policy, even though the politician's answer at present may be that he has no time or money to devote to such a matter.

But it is not, of course, only the things of the body that must be made secure for the citizen if we are to get his active attention and help in this fight. Not "by bread alone" shall we ever arm him for effective service. The question of security—for his family, for his job, and for his beliefs—arises. Without some degree of equanimity in regard to these things, without nutrition for his soul,

no man is a good soldier in any battle. Herein lies the value of wise leadership: the influence upon the nerve health of any nation exercised by good or bad statesmanship is incalculable. More and more is the modern citizen dependent upon a vision ahead of him, which he can understand and to which he can subscribe, if he is to resist disease.

2. The Doctor

Accessibility of both preventive and curative Health Services to every member of the community, which is the ideal to aim at, means personal contact of the doctor with the family as a unit, with the *whole* of the family, both the breadwinner and his dependants, when not sick as well as when sick: a real personal contact, not contact by propaganda, nor by health education, nor even by the provision of hospitals: the home should be brought under the doctor's scrutiny as well as its inmates. The best part of any doctor's work must always be domiciliary. The citizen should have free choice of his doctor and should enjoy continuity of care from him up to the point where institutional treatment is indicated and past that point whenever possible. Necessary ancillary services should be made easily available for him—hospitals, sanatoria, nursing, specialist advice, transport.

I must not stay to deal with the question of the doctor's efficiency and how to maintain it by postgraduate facilities, though these are important points in this connexion. The more the doctor becomes a public servant, the more should be done for him and for the community in this respect. In this country postgraduate education has lagged far behind that of other nations. Every large centre should possess a fully equipped Postgraduate Hospital and School, and attendance by a rota should be made compulsory.

3. The State

Passing to the function of the State in Disease Control, Mr. Walter Elliot has recently told us that "... Life and Death are the raw materials of the State, and those dealing with Life and Death must always and inevitably be under some compulsory connexion with the State, call it organization or what you will." But Life and Death are basic and ultimate; Health is variable. "More life and fuller"—not a bad definition of Health—which is our increasing need, can be the concern of the State just as much as "Life and Death," given the vision and good will which the State has a right to expect from the doctor and the doctor from the State. The existence of thousands of medical officers of health need not put the private practitioner out of his stride. The work of this group is supplemental to, not exclusive of, the work of the family doctor. Conflict implies a lack of appreciation of each other's functions, and provides but a spurious argument in favour of a "State Medical Service," which, indeed, is ill adapted to such a highly individualized society as ours.

To the duty of the State in regard to the overlap of Economics with disease control I have already referred.

4. Health Education

What degree of help in the control of disease may reasonably be expected from Education? I have already said that the units of any State being the citizens their active and intelligent co-operation is essential to the success of any policy or measure bearing upon health. Though he can be, and is, saved from many diseases in spite of himself, the citizen cannot be *made* healthy, because health is an active and not a passive thing.

It is not merely freedom from disease. In a democratic State the citizen's attitude must be that of "owner driver," not that of mere passenger. In countries that boast themselves as being "free" most acts of self-injury, or even of self-destruction, are permitted if they do not come under the legal definition of suicide. When the subject of quack medicines and their intimidating advertisements came under discussion in the House of Lords recently the Government apologist reminded their Lordships that "people have the right to make fools of themselves" if they so desire. But this principle is not acted upon consistently: the citizen is protected by the State against his own folly in a number of directions.

An analysis of our educational efforts in regard to the control of disease, admirable though they are, reveals that in many instances they are cancelled out by forces that meet the young citizen as soon as he is "on his own." The teaching of elementary hygiene is increasing in excellence, but the trouble is that the majority of young workers find themselves quite unable to carry out most of the rules that they have been taught in the schools. I shall consider presently how Industry has to some extent helped to deal with this difficulty. But, speaking generally, poverty blocks our educational efforts in many ways, because, as I have already remarked, to teach and to preach Health to the underfed and badly housed lacks conviction in the minds of both teacher and taught.

Again, health talks are largely neutralized to-day by the growing spate of advertisements of quack medicines and quack foods carrying with them the mass suggestion that without their use disease of some sort is unavoidable. Instruction on diet and nutrition is largely lost on the very citizens who need it most because the politician and the economist have not yet begun to tackle the problems of food production and food distribution. Some of the slogans heard about diet cannot be honestly endorsed by doctors because of their inconsistency. "Drink more milk," for example. How can we support this inspired advice when the Government continues to keep up the price of milk for human consumption and refuses to encourage pasteurization?

5. Emergence of Woman

It is not without interest to consider if the "Emergence of Woman" in executive positions, and the preponderant influence exercised by women's interests in several social fields, may not prove to be of considerable importance in Health Education, viewed in its widest sense. In the first of these relations may be put town councillors, doctors (both private and civic), industrial psychologists, dietitians, the heads of commissariat in various institutions, probation officers, almoners, and welfare and estate officers. In the second relation we have the influence of women as exercised in the non-political press, the radio, the films, and in advertisements.

There are several reasons for thinking that Health Education for the control of the simple diseases and of conditions which make for ill-health will in the future be undertaken largely by women. They have already led the way in the matter of more rational dress and also in house *ménage*, in which matter, as in some others, they have shown a tendency towards a healthy revolt against silly and health-sapping drudgery. Women, much more than men, are brought into close contact with the daily routine of the individual and of the family. For this reason they deal at first hand with those basic necessities of life out of which the very foundations of health are built.

Women, as I say, get a "close-up" with these things, and this "close-up" is independent of economics, of law, and of science. It is the duty of economics and social legislation to make these things available; it is the duty of science to explain why they are necessary. But it is the citizen, and especially the woman in the home and in society, who utilizes them in the direction of the preservation of health. The woman is therefore the unit which it is most important to recruit in the process of extending this part of the front in our efforts to control disease.

By an easy transition we pass from the woman in the community to the family unit, of which she is undoubtedly the key member. In a manner that is now becoming much clearer to us we must look at disease control as an everyday business rather than as a casual or occasional affair, such as going to see a doctor when a member of the family is ill. In my conception of the matter it will not be until health education takes the form of demonstrating within the family unit that its day-to-day routine is making a contribution to good health, or is sowing the seeds of ill-health, that the control of disease will arrive at its optimum of possibilities. To attain this end we may need some form of organization which will develop within the very framework of our social life—as a voluntary and not as an official process—this idea of health as being a going concern, to be enjoyed by all who will, and as a prerogative, if not of the people's own creation, certainly of their own maintenance.

In the Pioneer Health Centre, which we are to-day witnessing as a scale experiment at Peckham, we have an example of what can be done in this direction by people of vision and courage. Undertaken nationally rather than voluntarily, the scheme probably holds out more hope for the future than anything of this type that has yet been attempted.

6. Industry

The control front has developed in still another direction during the past two decades. I refer to Industrial and Commercial Enterprise. We have recently seen an effort, to which both Capitalism and Trades Unionism have contributed, to remedy some of the ill effects upon the people's health of the industrialization and urbanization of a nation that springs to a large degree from yeoman stock. This effort, made by the wealthiest section of our highly complex national life to offset the effects of its success upon the body and soul of the men and women who make its money for it, is likely to increase considerably in the future.

This task of combating the dysgenic effects of the changed environment of the workers presents several phases. Insurance schemes come into this category, including the various benefits under the National Insurance Scheme. So do State and Trades Union control of working hours, working conditions, wages, and the age of the workers. So does Factory Legislation, including factory first aid and factory welfare. So does Industrial Psychology, with its vocational selection and guidance and its planning in regard to workrooms and working efficiency. The Bournville scheme, with its apprenticeship classes, is an interesting and highly successful example of this same principle, tending to raise considerably the hygienic standard of the workers and operating during the whole of their life. Then there are several by-products of this advance the significance of which might easily escape attention unless the student of sociology is alive to their

meaning. In teaching and in research Medicine is being richly endowed by wealthy industrial magnates both here and in America. Inquiries into social and health conditions, made by organized groups of experts and producing reports of great value, are subsidized, or are entirely supported, by rich business firms.

All these numerous and widespread efforts to keep the workers healthy and contented, and—let it be admitted—profitable, must be included in our estimate of the factors making for disease control. The employer saves wastage, accidents, "absences through illness," and gets more and better work from his employees. The employees are fitter and (in the main, when not soured by the demagogue) happier. Whatever the motive, whether it be pure self-interest, or altruism, or overdue conscience money, or a mixture of all three of these (as it most often is), the result is a definite contribution to the lessening of disability and of disease. Unless in this country we change from our present capitalist system to a greater degree of State ownership all this work must inevitably increase and become more and more an important part of the line of defence against disease.

The weakest part of this particular sector is that which is precariously held by folk concerned in small businesses, domestic service, "city offices," and the like—folk who are not intelligent enough or sufficiently well off to make any provision for their workers, and oftentimes for themselves, on the lines just mentioned. There are thousands of these houses and rooms which are never inspected and whose occupants are under no sort of control.

III

Consideration of the main phases through which disease control has passed during that portion of time which we can properly study shows that these have been three. At first the sphere of progress was physical and chemical, then it became biological, and after that psychological. These phases overlap. We are still largely in the biological sphere; many of us, even yet, hesitate to accept the principle of the biological control of life. Genetics is a new science. Such important forms of control as the voluntary sterilization of the carriers of hereditary disease, and teaching mothers how to space their childbirths, continue to receive powerful opposition. In the psychological field the tempo is slower still.

And yet it is in these two spheres of biological and psychological control that we see most of our recent progress to have taken place. We may get a good indication of the direction in which the control front has extended during the past twenty-five years if we compare the contents of the first edition of Professor Rosenau's classical textbook on *Preventive Medicine and Hygiene*, published in 1914, with the sixth edition, published in 1935. The new sections in the last edition include maternal mortality, infant mortality, housing, health education, ocular hygiene, noise, mental hygiene for the normal, sex hygiene, and child hygiene.

I raised the question at the beginning of this lecture whether or no we are ever likely to get complete control over disease. It is a question that excites the imagination. *If we breed good stock, if we "get back to Nature" in the matter of food and air and sun, if we are clean, if we achieve equanimity, and if we are really convinced that it is "better being well than ill"—shall we then be free from disease? Will control be absolute? Shall we live an effective life into very old age, and, at last, "like ripe fruit drop into our mother's lap"? Or*

will it be with Health as the wise man warned us it is with Happiness: shall we call no man healthy until he is dead?

Ultimately the answer to this question must depend upon the two things, interaction between which constitutes disease: one is the causative agents of disease, and the other is man himself. Changes in either, or in both, of these would delay control, it may be indefinitely, and change is of the very essence of living things: change, but also persistence. Elsewhere I have dealt with an aspect of this matter in speaking about New Diseases and Old. In relation to the large field of microbic diseases, to name only one, there are elemental forces at work which still confound the epidemiologist.

And what of man himself? Will man invent new diseases as time goes on? Is he less inscrutable, less wilful, less errant, because modern psychology has made his nature more clear to us? Or will he always be as Henry Vaughan depicted him?

"... Man hath still either toyed, or Care,
He hath no root, nor to one place is tied,
But ever restless and Irregular
About this earth doth run and ride,
He knows he hath a home, but scarce knows where,
He says it is so far
That he hath quite forgot how to go there.
He knocks at all doors, strays and roams,
Nay hath not so much wit as some stones have
Which in the darkest nights point to their homes,
By some hid sense their Maker gave;
Man is the shuttle, to whose winding quest
And passage through these looms
God ordered motion, but ordained no rest."

Upon the result of such speculations as these depends the answer to the intriguing question with which I began, and with which I now close.

ZINC-PROTAMINE-INSULIN IN DIABETES

TREATMENT BY ONE DAILY INJECTION

BY

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Protamine-insulin compounds have been used in this country for three years, and sufficient time has passed to appraise their value in the treatment of diabetes. The earlier insulin was a clear soluble preparation, but the addition of protamine produces a cloudy precipitated compound which is more slowly absorbed from the site of injection and hence slower and more prolonged in its action. At first a simple insulin-protamine compound (Leo insulin, retard) was used in this country, but later it was found that the addition of traces of zinc made the compound still less soluble and more prolonged in action. Zinc-protamine-insulin is the only protamine compound manufactured here, and it is more generally useful than the original preparation; therefore its use alone will be described.

Insulin treatment has never been as simple as giving a bottle of medicine, and in the past it usually involved two or even three injections a day—no easy matter for many patients. The new type of treatment is sufficiently different from the old to introduce at first new complexities for the practitioner accustomed to the latter. But I hope to show that treatment with zinc-protamine-insulin is easier and simpler for the doctor and his patients, and that it ought to extend the benefit of insulin to thousands of patients who, although they needed it, did

not get it. Indeed, the qualities of zinc-protamine-insulin make it the *practitioner's insulin* for choice.

Insulin Requirements of Different Diabetics

Before we pass to the details of the new treatment it is important to consider the varying degrees of insulin deficiency in diabetics, because the difference between a mild and a severe case is so great as to require an almost entirely different use of insulin. We have reason to believe (Lawrence and Archer, 1936) that in normal people there is (1) a small continuous secretion of insulin, a *basal* secretion, which controls endogenous sugar production and controls the fasting blood sugar, and (2) an increased secretion after meals to deal with the absorbed carbohydrate. In diabetics both these aspects of insulin secretion are defective, but the clinical pictures vary widely with the degree of insufficiency. Mild cases, still producing some insulin, are controlled either by diet alone or by small added doses of insulin which are necessary mainly to deal with carbohydrate food, the patient's own basal supply of insulin being sufficient to keep the blood sugar normal, or nearly so, except after meals. In more severe cases injected insulin is required not only to deal direct with carbohydrate food but to control the continuous outpouring of sugar (and acetone bodies) in the fasting condition. The problem of maintaining diabetic control and good health in mild cases is therefore very different from that of severe cases. The properties of the various insulin preparations are summarized in Table I.

TABLE I.—Adults

Type of Insulin	In Doses	Duration of Action	Commonest Time of Hypoglyc.	Remarks on Type of Action
Soluble	to 10 units	5-6 hours	2-4 hours	Quick and strong. Balances much carbohydrate
	to 20 "	6-8 "	3-5 "	
	to 40 " +	10-12 with big doses	6-8 "	
Retard	to 20 units	8-10 hours	4-6 hours	Slower. Balances less carbohydrate
	to 40 "	12-16 "	6-9 "	
	to 60 "	Occasionally 24 hours	7-12 "	
Zinc-protamine-insulin	to 10 units	6-8 hours	5 hours	Very slow. Balances carbohydrate poorly
	to 20 "	to 12 "	8-12 "	
	to 30 "	to 18-24 hours	8-20 "	
	40 units or more	24 hours or longer	16-24 "	

Soluble insulin is quick and strong in controlling the sugar from the carbohydrate meal following, but it is so short-lived in action that one or even two doses never provide a continuous supply. It acts in strong waves, which may even produce hypoglycaemia twice a day without preventing a relapse of sugar and ketosis in severe cases when its action is exhausted in six to nine hours. Zinc-protamine-insulin, on the contrary, provides a constant small amount of circulating insulin sufficient for a basal supply but too weak to control sugar after carbohydrate meals. It is also more *irregular* in its action from day to day than two doses of soluble insulin, possibly because of more irregular absorption. When these contrasting qualities are realized, the value and limitations of the old and the new insulin in treatment are easily appreciated.

When a new case of diabetes is discovered it is often difficult to decide whether insulin is necessary at once. In this decision the tests for acetone (ketone) bodies are even more important than the degree of glycosuria and hyperglycaemia. If ketonuria is present in more than traces