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THE SCIENCE OF HEALTH*

BY

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For my annual wartime lecture I have chosen on this occasion a subject which, curious though it may seem, finds no special place or mention in the curriculum. Medicine is primarily concerned with the observational study (with a view to its relief) of disease at the bedside, in the consulting-room or clinic, and in the laboratory. Disease also has its own science of Pathology, which is concerned with the more intimate laboratory investigation of its causes, processes, and consequences. But, notwithstanding that the study of health would seem to be the proper preliminary to the study of disease, we find no counterpart to medicine, no parallel observational science devoted to the fireside or field-side or laboratory study of health. Nor is there a science comparable to pathology which deals with the more intimate causes, processes, and consequences of health.

Hygeia, the daughter of Aesculapius, was the goddess of health, a subject in which the Greeks were intensely interested, and hygiene originally meant the science of health; in modern usage, however, it has come to convey the narrower meaning of sanitary science. Physiology and anatomy, it is true, concern themselves with some of the processes and attributes and supply some of the standards of health; but as a rule they have little to say of its outward manifestations, of what may even be called its "symptoms and signs," or of that elaborate co-ordination of functions by which it is constituted. They touch scarcely at all upon its causes and consequences.

Please do not think that I wish to extend or complicate the curriculum, but it is surely an omission that so little attention has been paid by the students of disease and their teachers to that state from which some deviation or departure must occur before the existence of disease is recognized. And so, because it has a bearing on your future tasks and outlook, I suggest that we give our minds to the subject of health and how it might be better regarded and how more usefully observed and studied. Let us begin by asking ourselves five questions: (1) What is health?; (2) Why is it important to know more about health?; (3) What are the principal symptoms and signs or other criteria of health?; (4) What are the causes and consequences of health?; and (5) How in the future can we make a better contribution to the promotion and maintenance of health?

What is Health?

There are difficulties in the matter of health as a concept. It is not at all an easy thing—less easy even than disease—to define, and most existing definitions are inadequate. My *Oxford English Dictionary* defines it as "soundness of body," my medical dictionary as "a normal condition of body and mind." The first of these is clearly insufficient. The second leaves us with the old indecision as to what we mean by normal. It is possible for a man to pass every physical and chemical test known to medicine and yet to be a very sick man—to suffer, for instance, from severe recurring bodily discomfort or continuing mental anguish. On the other hand, he may

be left by disease or injury with gross physical defects, including loss of limbs, and nevertheless be abounding in vigour and surpass in efficiency and happy achievement the majority of his unscathed contemporaries. We must also allow that the criteria of health vary with age, sex, occupation, and race.

A good definition of health in the individual should convey the idea of competence to perform and enjoy the tasks and functions appropriate to his or her age and sex. It should convey the idea of well-coordinated function, of life vigorous, well balanced, and attuned to its environment. It should certainly mean something more than a state of "no disease." In the training camps for the Army there are at present gathered together many young men who have been passed as fit for military service. After a few months of training they are already an entirely altered set of men in appearance and bearing and physical efficiency and mental outlook, and they not infrequently gain half a stone or more in weight in that period. In addition thousands of men accepted for service are later found unfit to go through with their training. All these were medically examined and labelled as fit for a virile profession, but they were obviously a long way from the optimum or possible vigour and development due to their manhood and original physical endowments. They had not really achieved health.

If we go back to the *O.E.D.* and look up, not its definition but an earlier alternative for the adjective "healthy," we come, I believe, a little nearer to what we are seeking. The old adjective for healthy is "hale." From "hale" the word "whole" is also derived. "Hale," we are told, means "free from infirmity; sound; vigorous"; but "whole" has also come to convey the idea of completeness. By "the whole man" we can understand not merely the "total man" in a structural regard but man in the fullness of his functional development and integrity—that is to say, in a physiological and a psychological regard. The B.M.A. Medical Planning Commission has recently coined a much-disputed phrase—"positive health"—implying thereby something better than "no disease." It does not bear close analysis, and, if we accept the idea of health as wholeness—implying fulfilment or completeness and co-ordination of function—the prefix "positive" becomes unnecessary.

We are not, however, to infer that there is only one pattern of health or wholeness; for we know that the human species, like other domesticated species, shows a wide range of variability. Health manifestations, like disease manifestations, can vary from individual to individual. But we may insist that for each main type or variation due to race, parentage, age, and sex there can be laid down certain criteria over and above the mere absence of detectable disease which stand for wholeness or health. These criteria have still to be more precisely determined and described, for reasons which we must shortly discuss. Their description and measurement are among the tasks of the science of health.

Why is it Important to Know More about Health?

This question may be considered from the point of view of the student of medicine, the individual citizen, and the community. Unless the student of medicine (be he qualified or

* An undelivered lecture prepared for the students of the Medical Faculty, University of Cambridge.

unqualified) has a good working knowledge of health and health standards and manifestations, of the nature or physiology of what I shall describe as the "symptoms" of health and of its surface markings, he is not in a position to detect or investigate the early deviations from it. Unless, furthermore, he appreciates that most of the symptoms of disease can be explained physiologically as exaggerations or depressions of the ordinary symptoms of health he will fail to appreciate those natural gradations between healthy and morbid function which are constantly discoverable in practice, and he will tend to think vaguely in terms of "normal" and "abnormal" as though there were a sharp division between the phenomena of health and the phenomena of disease.

Dyspnoea in response to vigorous exercise is a symptom of health. Dyspnoea at rest or with trivial exertion is a symptom of disease. Flushing in a hot atmosphere is a symptom of health. It is also a symptom of fever when the internal, as opposed to the external, environment is modified by disease. Appetite is a symptom of health; poor appetite and loss of appetite are among the most significant symptoms of disease.

There is, however, quite another reason why the student of medicine should wish to know more about health. It is linked with a present and important reorientation of our professional thought. It is becoming steadily more apparent that in the future the emphasis of medicine will be increasingly upon its preventive and protective aspects, upon the social as distinct from, but supplementary to, the individual applications of accumulating knowledge. Instead of waiting to cure—or to try to cure—the individual of preventable disorders and diseases we shall endeavour to see that conditions are such that fewer and fewer individuals develop them; and, not content with those states of body and mind which can only be called "no disease," we shall encourage by every method within our power the preservation of health and the elevation, in the minds of doctors and laity alike, of the idea and the standards of health. Apart from the hundreds of thousands of people in these islands who suffer from active and diagnosable disease and are either bed-ridden or in other degrees incapacitated from full and useful citizenship, there are millions, like the recruits to whom I have referred, who might by our present rough standards be placed in category 'A', but who could not—while lacking signs of evident disease—be considered as really healthy or whole. Although unalterable ancestry would commonly be found to have provided initial handicaps, environmental factors (in many cases alterable), operating on body or mind, or both, would be found to have the more widespread adverse influence.

The better and earlier assessment of the lesser degrees of what we have come to call "ill-health" (really a contradiction in terms) in individuals and the community is becoming an urgent duty. The study and recognition of the causes of disease and debility, and of those states which have no name and often evoke no open complaint but which fall just short of health, have led us back at last to the recognition and the need for the better discrimination of the causes of health itself. To some of these I must shortly refer, but they are nowhere better illustrated than in the field of nutrition.

If you want illustrations of what I have in mind you have only to keep your eyes open in buses, tubes, and trains and to ask yourselves what proportion of your fellow travellers, even on a superficial and untrained inspection, would be likely to prove really healthy or whole. In mining and industrial districts and slum areas you would find the levels of fitness more conspicuously on the debit side; for here you would see at all ages a far greater proportion of stunted bodies, pale faces, and bad teeth. Here, too, on a basis of the same crowding and poverty, tuberculosis, rheumatic fever, and diphtheria find the opportunity which they are ceasing to find in kindlier social climates. Briefly we may say—and none could dispute us—that health or wholeness is far too rare, that the standards of health which we have allowed to pass are far too low, and that many of the causes of this state of affairs are now apparent and are to be found in defects of environment, of education (both mental and physical), and of rest, recreation, ventilation, and nutrition. As the doctors of the future you must begin to think how this situation can be remedied. By demonstration of what can, in fact, be quickly achieved, as through the provision of better conditions for two sections of the

community only—the elementary-school child in peacetime and the recruit in wartime—the people as a whole must eventually be persuaded of the possibility of the real health that is their due. What they ought to possess and its importance in a national regard have long been recognized, as witness the old adage, *Salus populi suprema est lex*, or Disraeli's insistence that "the health of the people is really the foundation upon which their happiness and all their powers as a State depend."

The health of the people has been greatly served, let us admit, by a number of epoch-making discoveries, by numerous public health measures, by political and economic changes and (except in the matter of war-proneness) by the general upward trend of our civilization. Curative medicine and surgery have also played no inconsiderable part. In future the preservation and wider distribution of health in the community, based upon a better understanding of its causes and not only on a knowledge of the causes of disease, will make contributions as remarkable as any of these.

But if we are to control health we must know how to diagnose it and we must further elucidate its causes. It is by such means that we have learned to control disease. Pathology has provided the basis of much physiology. Similarly clinical study can point the way to the study of health, for clinical training provides the right methods and encourages the right aptitudes, although it has not always led as promptly as it might have done to the right inferences and actions.

The Symptoms and Signs of Health

We all know vaguely what we mean when we say that we "feel fit." The top-of-the-world feeling at the height of a good holiday; the keen appetite and good digestion and regularly acting bowel; the pleasing muscular aptitudes; the tingle of bare skin in sun or wind and its free response to changes of temperature and to exertion; the pleasant sense of muscular fatigue at the day's end (so different from city weariness); the even temper; the gay spirit and the ready laughter—all these are symptoms of health. In youth many of them are experienced apart from holidays. The older we become and the more occupied with affairs and cares and sedentary occupations, the less fully aware are we of all these pleasant sensory phenomena and the more surely does it require a long holiday in good surroundings to recall them. As the mode of our lives becomes less wholesome we become, indeed, less whole. We may well wonder whether the working men or women in the poor streets of our crowded cities, whose holidays seldom if ever run to a week and whose incomes rarely allow of rest and refreshment in the country or at the seaside, have ever enjoyed what most of us here have enjoyed of true health or wholeness.

Now, just as loss of appetite, irregular bowels, undue fatigue, poor sleep, greasy or dry skins, ruffled tempers, and low spirits—not to mention more definite aches and pains or depression, dyspnoea, or dizziness—have their diagnostic significance and physiological interpretation, so too have the subjective phenomena of health their diagnostic significance and physiological interpretation. Their more intimate meanings have not in most instances been fully worked out as yet, for bodily and mental sensitivities are still more delicate than our chemical and physical tests. Professor Adrian has not tapped or taped them all with his electro-encephalogram, or taught us how to amplify them with his loud-speaker for purposes of demonstration or analysis. But this does not mean that they cannot in the meantime be usefully studied by observational and descriptive methods and elucidated by inference and comparison; or that their causes cannot be sought as physicians have long sought, by patient watching and record, the causes of their counterparts—the symptoms of disease. Their study is naturally helped by parallel observations on the objective manifestations or "signs" of health. The fresh colour and fine texture of the skin, the crispness and lustre of the hair, the good teeth, the sweet breath, the upright and graceful carriage, the firm limbs, the easy breathing, the frank manner, the free movements on the track or the tennis court or in the swimming-pool—all these are among the eloquent signs of health in youth. In the child we see the softer skin and other sprightliness of movement, other gaieties, the skipping progress of the small girl home-coming from school; in the infant the firm roll of fat at the wrist, the contentment, the absence of crying (except

under the compulsion of hunger or a passing pain), the earnest attempts at crawling, standing, or walking, the lovely postures of sleep; and in the old—even though movements now be slow and memory less quick and laughter a less boisterous affair—we sometimes witness the silver locks and rosy porcelain skins and a serenity of mind which are the true manifestations of health in age.

And when as physicians we have occasion to make our routine examinations at these various ages we learn that there are behaviours in respect of body-weight and build and growth and sleep and bowel and bladder function, of menstruation, of pulse rate and blood pressure and haemoglobin percentage, which are appropriate and natural and may be counted among the measurable criteria of health. Or we may detect departures from them which give us pause or, may be, lead our inquiries to the discovery of incipient or established disease.

Why should you not begin your training in the observation of these things now? Why should you not seek for physiological explanations of the familiar symptoms and signs consistent with well-being or its borderland states, that you may the better recognize those of more patent disorder or disease when they begin to come your way? Appetite, hunger, satiety, laughter, blushing, hiccups, yawning, sneezing—here are familiar symptoms ready to hand and inviting your inquiry. I suggest that you try and write a full description of any one of them to-morrow. I should like one day to see some good cinematographic illustrations of man's strange convulsive phenomena—of laughter, sneezing, and hiccups—and to study them in slow motion. The better you can describe and explain these events, the better, later on, will you describe and understand fits and flatulence, nausea, vomiting, and vertigo when you take up your work in the clinic. There, although it is common—too common—to account as “interesting cases” only those of the more rare or advanced diseases, it should really be our first pride and purpose—remembering the features and phenomena of health—to detect the earliest departures from it, to recognize morbid conditions when they are more susceptible of arrest or cure, to be more familiar with those multitudinous shades and varieties of unfitness which might have been altogether avoided. For the physician with a naturalist's eye, moreover, the study of all these phenomena of life, whether healthy or morbid, can come to have a fascination of its own, and quite apart from special uses.

The Causes and Consequences of Health

The causes of health, like those of disease, are to be found in ancestry and environment. In nature (which we will assume to mean in all wild species living under conditions unmodified by man) the survival of the more robust and adaptable breeds and individuals, together with natural activity, results in the maintenance of a high and even curve of health. The unfit do not long survive, and, whether in a nest of ants, a flight of swallows, a school of porpoises, or a herd of deer, it is unlikely that the most skilled clinical survey would reveal anything like the variability in body-form, weight, colouring, vigour, and other criteria that such a survey would reveal, shall we say, in domesticated cattle or a native tribe. In a so-called civilized community the variability is far greater, and deviations from the mean in respect of stature, colouring, and health, and even the unlovely features of declared disease, are all more frequent and more apparent. Variation under domestication was, as you know, one of Darwin's special studies. Man has constantly increased his variability as well as that of his domestic animals. His animals he has bred for new types, for quality, and for quantity. By his own modes of living and social organization, however, he has produced many deviations from health, and by his self-protective measures he has made it possible for the unfit to survive in large numbers, whether their unfitness has been due to genetic or environmental factors, or to both. He has both bred morbidity and preserved it. And now he is seeking the answers to his mismanagement.

Students of eugenics (which has been defined as “the study of agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally”) formerly applied themselves especially to those hereditary influences which are accounted inimical or favourable to man. To-day they are more alive to the importance of environmental influences and to the fact that these are also

more controllable. Medicine and preventive medicine and other forms of social service, together with physical training and education, are among the agencies whereby we have sought to keep individuals and communities in health. It is clear that we cannot at present influence national health to any great extent by applications of genetics. We cannot adopt the methods of the stock-breeder with his flocks and herds. Such is our respect for the liberty of the individual—and, I might add, our disrespect for the race—that we cannot yet control, by segregation or sterilization, the excessive fertility of village half-wits who perpetuate their kind with multiple illegitimate births. We cannot at present even do much towards encouraging the general fertility of the fit and discouraging the general fertility of the unfit. Economic and other insecurities have tended to the serious artificial limitation of families on the part of those most worthy to rear them.

There are, however, a number of things that could be done to ensure and assist the health of the people by modification of their actions and habits, their nutrition, and their environment. Better food, better education in the purchase and preparation of foods, better general and technical and sex education, better wages, better housing, social insurance, holidays with pay, opportunities for games and recreation, the provision of every advantage which infantile and child health and growth require—these are possible things. These are themselves among the more important causes of health. And in the schools and the universities, in the Services and the training camps there should be ample opportunities for the more intimate study and measurement and cultivation of health, and for physiological experiments in health regulation and control. The study of growth in childhood and adolescence and of the relative influences here of nature and nurture awaits a full inquiry.

You will rightly comment that the social reorganization needed to provide the adequate causes of health is not within the immediate province of science or the doctor. It is not my purpose here to go outside that province except to remind you that it is upon the wise application of science to human problems that some of our greatest human and social advances have been and must in future be based. The more carefully you use your eyes and other sense-organs, the more accurately you collect and correct your data, the more factual arguments you can assemble to show that health or wholeness is something better than “no disease,” that its symptoms and signs and measurements are this and that and its causes or antagonists such and such, the more incumbent will it be upon peoples and their Governments to ensure that the lessons of your science are eventually and effectively applied. They took the advice of doctors about infectious disease as it were but yesterday. To-morrow they will take it about nutrition and housing and working hours, and that degree of security of prospect without which it is impossible to maintain full sanity of mind and soundness of body.

Of the consequences of health need we say more than that it paves the way for happiness and performance and makes for more effective individual and national life and labour, and so helps production and prosperity and provides, in fact, a nation's best economy? How much fitter our recruits would have been, how much less striking the contrast in stature between many of our home troops and their cousins from overseas, and by how much our war output might have been increased in these war years, if we had attended to health as assiduously as we have attended to wealth in the pre-war years! And what a nation we could become again if we would but accept and act upon the fundamental principle that, for the individual and the community, health of body and mind and the things that secure them are the most important of all economies and the surest shield against adversity and discontent and conflict! To quote Disraeli once again, “The health of the people is really the foundation upon which their happiness and all their powers as a State depend.”

The Future

If the human world can be saved from its most immediate enemies and dangers, the future, or an important part of it, will be in your hands. To its better building you must direct your science and your humanism, and you must see that these two forces work in the closest partnership. The word “doctor”

means "a teacher," although in this country it has also come to have the more special meaning of "healer." One of the functions of doctors is to contribute of their knowledge and experience to the development of a healthier and happier state and to the education not only of the people but of the people's leaders. I would urge that your science and your humanism must come to serve the State in fuller measure than the science and humanism of the older generations have done.

Will you accept, therefore, that you are going out into the world in a few years' time not only to cure and palliate disease but—true to your title of doctors—to teach health and the causes of health and the necessary provisions for health, remembering always that this teaching must first find a firm basis in the science of health? Towards all this your present studies provide an important introductory discipline—but only a partial one, for the emphasis of teaching is often in the wrong place, and the co-ordination of your many subjects is not yet what it might be. In much the same way it may be urged that our existing medical services often apply the emphasis in the wrong place and lack the co-ordination we would one day like to give to them. And so will you in your generation also help us in ours to bring health or wholeness to our educational systems and to those collaborations of social and individual medicine with which it will one day be your privilege and responsibility to serve the people of this and other countries?

Last of all, for I have not yet mentioned your very proper duty to yourselves, remember that the doctor who has poor opportunities or a scant regard for his personal health—which above all other blessings should bring balance to his life and judgment to his work—can scarcely become the most respected and effective teacher.

TREATMENT OF SUPERFICIAL TUBERCULOUS LESIONS BY LOCAL APPLICATION OF PROMIN*

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The results obtained by Feldman, Hinshaw, and Moses (1940, 1941, 1942) in the treatment of experimental tuberculosis in guinea-pigs by promin (sodium salt of *p,p'*-diaminodiphenylsulphone - N, N'-di - [dextrose sulphonate]) have aroused great interest both in America and in this country. Not only did the drug, given daily by mouth, prevent or limit the development of disease, in animals inoculated with a virulent bacillary strain, when treatment was begun on the day of infection, but even when it was delayed for six weeks thereafter the effect was pronounced, and in some animals no tuberculous lesions were found at necropsy 192 days after inoculation. Feldman, Mann, and Hinshaw (1942) have now repeated the experiments, but have proved by biopsy the presence of microscopic tuberculous lesions in the livers of the animals when treatment was started, six weeks after infection; and again several treated animals showed no lesions at necropsy, at 224 days. While some factors involved in these results require further discussion, they appear to be the most impressive yet reported in the chemotherapy of tuberculosis in the guinea-pig.

* The drug has been developed by Messrs. Parke, Davis and Co. Ltd. in America, where the name "promin" was given to it; but in this country, owing to difficulties in registration, it will be known as "promanide." It will, however, be referred to in the article as "promin."

The guinea-pig tolerates a daily dosage, by mouth, of 300 to 400 mg. over long periods. In man, unfortunately, much lower dosage relative to weight may soon produce toxic effects, particularly haemolytic anaemia. Trial treatment of pulmonary tuberculosis has been fairly extensive, though published results are yet scanty. But, from wide informal discussion, it appears that outstanding success has not been attained with any dosage which is well tolerated.

One of us (W. H. T.) has had in hand for some seven months a guinea-pig experiment similar to those of Feldman, Hinshaw, and Moses, with comparable results, so far as they are yet apparent. The very evident effect of the drug in this experiment suggested that it might be exploited in the treatment of accessible non-pulmonary lesions, to which effective concentrations might be applied locally without producing a toxic blood level. After treatment of this type had begun, we learned that in America promin has been applied locally by spray or inhalation in some cases of laryngeal or tracheo-bronchial tuberculosis, with good results. More recently we have heard, by personal communication, that Dr. G. T. Allerton of Torquay has been applying the drug to superficial lesions with much success.

Method

The high solubility and rapid absorption of promin indicated that the maintenance of an effective concentration in the lesion might require frequent application of strong solutions unless the drug were incorporated in a medium which would limit diffusion. The medium first tried was tragacanth, which at relatively low concentrations gives a stiff insoluble jelly; and this medium has proved so satisfactory that no extensive trial has been made of others. One preparation of promin and tragacanth in glycerin was made, in the hope that the gum, by absorbing water in the lesion, might produce a stiffer gel than could be injected, but the preparation in itself proved difficult to handle and to inject. The use of tragacanth, however, makes sterilization difficult. Promin in 40% solution may be autoclaved at 120° C., and if cooled slowly remains in solution, particularly if 5% glucose has been added. If the solution is cooled rapidly, or with weaker solutions in any case, precipitation occurs, though solutions of 1% or less only become hazy. But, owing to the insoluble nature of the tragacanth gel, and to the stiffness required, it is not practicable to sterilize the gel separately and then add the necessary promin in sterile form. For the lesions so far treated, therefore, we have not attempted sterilization, but have relied on the bacteriostatic effect of the drug, which is considerable at the strength used. For injection into closed serous or similar cavities, however, it would be desirable to develop some method of sterilization which would exclude the presence of viable spores, particularly those of *Cl. tetani*.

In the preparation of a smooth jelly the most important step is the rapid dispersion of the tragacanth powder throughout the aqueous solution, before swelling and lump formation occur. The promin solution, in a beaker, is stirred mechanically by a rapidly rotating propeller blade, and the tragacanth is dusted in directly over the blade. The jelly is then smoothed out by sucking in and expelling through the bare nozzle of a large syringe, and finally by expelling through an attached needle (18 S.W.G.). Two different batches of tragacanth have given satisfactory gels at 3.5% and 3.0% respectively, the stiffness being such that considerable pressure is required to force it through the needle. In use the jelly is either sucked into the syringe through the bare nozzle, or may be filled into the open barrel, and injected either through the needle or, for sinuses, through a fine catheter tied to the nozzle. The first jelly contained 5% promin, which caused no irritation, and was increased to 10% and then 20%. The latter caused increase of exudation, and though the end-results were good we have now gone back to 5% as giving equally satisfactory results.

At the time of writing 10 cases have been treated in Glan Ely Hospital, Cardiff, of which notes are given below. So far, only such lesions have been selected as were easily accessible either to aspiration and injection or to instillation into open sinuses.

Case Notes: Closed Abscesses

Case 1.—Man aged 25. June 13, 1942: Admitted Glan Ely Hospital. Pulmonary tuberculosis, caries dorsal spine. Abscess pointing in lumbar region; 170 c.cm. pus aspirated; 5 c.cm.