

# Nutrition in Health and Disease

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THIS is an historic occasion. The inauguration of the *Section of Nutrition* is the recognition by the Association that the science of nutrition is an integral part of medicine. Last among the sections, it is not the least; indeed, the day is not far distant when, instead of one morning being devoted to its work, it will rank with the section of medicine as a three-day fixture. For with the rapid increase in knowledge it becomes more and more apparent that the science of nutrition is the foundation of a more rational medicine. It is to be hoped that on future occasions the work of this section will not be limited to physiological, biochemical, pathological, and medical aspects of the subject, but that it will include those that are veterinary and agricultural.

Although young in years the newer knowledge of nutrition has already established contacts with, indeed embraces in its compass, every branch of our profession. It may, therefore, serve as a fitting introduction to to-day's discussion to indicate, though without aiming at completeness, what these contacts are; taking the nineteen other sections, into which the clinical and scientific work of the Annual Meeting is divided, as the basis of this survey.

First then, in regard to *Medicine*, which heads the list of the sections, and with which *Public Medicine and Diseases of Children* may be included. What contacts has the science of nutrition established with medicine? This question can best be answered by defining "medicine" and by defining "nutrition." For the first definition we may look to a lay, or non-professional, dictionary, to find what the public expects of medicine. There it is defined as "the science or art of the prevention, treatment, and cure of disease"; not merely "any substance given for the cure of disease"; not merely "the science of the treatment of disease"; not merely "that branch of the healing art dealing with internal diseases." It is significant that in this definition prevention takes precedence of treatment and cure. Medicine is, in short, the science and art of maintaining health.

## Definition

And what is "nutrition"? It is a fundamental function on which the condition of the body - that is to say health -- depends. It is not merely "food" nor "that which nourishes," as some lay dictionaries define it. Food is the instrument of nourishment; nutrition is the act of using it -- the series of co-ordinated processes whereby the nourishment of the body is

effected. It consists in the taking in and assimilation through chemical changes -- metabolism -- of materials with which the tissues of the body are built up, their waste repaired, and their deterioration prevented; by which the processes of the body are regulated and co-ordinated, from which energy is liberated for the internal and external work of the body, and from which heat is generated for the maintenance of its temperature.

A primary purpose of the function of nutrition is, thus, to establish and to sustain the structure and function of all organs and parts of the body: to keep, in short, the mechanism of the body in perfect running order. And since health, at its best -- for it is a variable state of being -- is that condition of body in which all its organs and parts are sound and perform their functions duly, easily, and satisfactorily, it follows that a primary purpose of the function of nutrition is to prevent, so far as its limitations permit, that disturbance or impairment of structure or function of organs or parts of the body which is disease.

This, then, is the relation of nutrition to health and disease -- the subject of our discussion to-day -- the answer to the question: What contacts has nutrition established with medicine?

The older knowledge of nutrition showed the fundamental relations of the energy-yielding constituents of food to vital activities. It showed, also, the importance of the protein factor in nutrition. But it is only within recent years that the equally important relations of certain food-essentials -- notably, mineral elements and vitamins -- to the structural and functional efficiency of the mechanism of the body have received their due meed of attention. The study of these relations has led to a new conception of causes and origins of disease: a conception which may be summed up in the sequence -- faulty food, faulty nutrition, faulty function, faulty structure, faulty health, disease. It is with this newer knowledge of nutrition, and not with the energy requirements of the body, that we are concerned to-day.

## **Factors Affecting Nutrition**

Nutrition, as we all know, depends on a number of factors: the constitution of the food, the adequate oxygenation of the blood and tissues, the efficiency of the processes -- digestion, absorption, assimilation, circulation, excretion -- involved in this function, proper exercise of the body, rest and sleep, freedom from worry and emotional excitement, general hygiene, sunlight, and inherited characters. Chief among these is food of a constitution that provides all the elements and complexes needed for normal nutrition.

Moreover, the lack or insufficient supply of one or more of these essentials, or their disproportion one to another, may be the determining cause of some of the other factors that adversely affect the function of nutrition, thus creating a vicious circle. Imperfect oxygenation of the blood and tissues may, for instance, be the outcome of specific food faults. Restlessness and excitement may be consequences of faulty feeding. Food of

improper constitution may be the cause of impairment of any of the processes involved in nutrition. Defects in diet may enhance the harmful effects of want of sunlight. Food is thus the greatest of all factors on which the efficiency of the function of nutrition depends. It is the foundation of health; chief amongst the armaments of medicine against disease. "There may," as Holt aptly expresses it, "be normal nutrition without normal health, but there cannot be normal health without normal nutrition."

Here the question arises: what are the materials wherewith the function of nutrition is effected and whence are they derived? They are, so far as is at present known, oxygen, water, and the digestion products of proteins, fats, carbohydrates, mineral elements, and vitamins. There may be others, probably there are. So we are on surer ground when we consider the foodstuffs which, when properly combined in the diet, are known to ensure perfect nutrition and a high grade of physical efficiency and health in human beings. These foodstuffs are:

1. A good whole cereal grain or mixture of whole cereal grains or a good wholemeal bread.
2. Milk and the products of milk -- butter, cheese, curds, buttermilk.
3. Egg.
4. Green leaf vegetables.
5. Root vegetables -- potatoes, carrots, etc.
6. Legumes.
7. Fruit.
8. Meat.
9. Water.

That these provide all elements and complexes, known and unknown, needed for normal nutrition is evident from the fact that they are the ingredients of the national diets of certain races of northern India whose physique and health, when they make use of their national diets in their entirety, are unsurpassed by any other races of mankind. Further, albino rats, when fed on a diet made up of these ingredients, can be maintained in perfect health. [1]

Most of these foodstuffs are nowadays classed as "protective foods" [2] -- a discovery made centuries ago by the races referred to, and of which the newer knowledge of nutrition has revealed the importance. If food be the foundation of health, these foodstuffs are its foundation-stones. Using them aright there is little need to concern ourselves too closely with the precise amounts of this or that chemical ingredient of food that may be necessary for normal nutrition. These foodstuffs provide them all and in due amount and proportion one to another. There is, however, this proviso, that they must be produced on soils which are not themselves depleted of essential plant nutrients or of substances, such as iodine, needed for the normal nutrition of man and animals and conveyed to them by plants. "Les plantes sont les enfants, de la terre, de l'air, et du soleil"; and we, in common with other animals, are the offspring of the plants.

Here it may be remarked that important as properly constituted food is at every period of life, it is at no period so important as during infancy and childhood; for then it is that the

body is being built, then that defects in its structure and efficiency are so readily established, defects that are at the root of many of the diseases to which man is erroneously supposed to be heir.

## **Bacteriology and Pathology**

So much, then, for Medicine; now as to the contacts of nutrition with bacteriology and pathology. First, as regards the relation of nutrition to resistance to infection. Not long ago, Clausen submitted the available evidence on this question to critical analysis. His general conclusions were as follows:

"Resistance to infection may be greatly reduced by deficient diet. A deficiency in the diet of vitamin A or of vitamin C appears quite definitely to lower resistance to infection. In certain cases a lack of the vitamin B complex may also do same thing. A lack of vitamin D [per se] cannot be have a proven effect in lowering resistance it occurs [such lowering is usually due to associated deficiency of vitamin A]. It seems probable that the existence of a partial deficiency [of vitamins] may result in loss of resistance to infection..."

Under "deficient diet," as mentioned in these conclusions, there are to be included deficiency of protein and deficiency of certain mineral elements, notably calcium.

The contacts of nutrition with pathology may best be illustrated by the effects of faulty nutrition on the digestive and endocrine systems: the former a highly specialized mechanism designed for the nourishment of the body; the latter a highly specialized mechanism designed for the control and co-ordination of the round of chemical changes (metabolism) on which nutrition depends.

## **Gastro-Intestinal Tract**

The discovery of the effects of deficient and ill-balanced food on the gastro-intestinal tract is "one of the most significant contributions to the role of nutrition in preventive medicine." [3] This discovery was made [4] by feeding monkeys on diets having a number of faults -- poverty of vitamins and mineral elements and excessive richness in carbohydrates: faults common in human dietaries. "Deficient foods are in practice usually ill-balanced foods, and the effects of avitaminosis are bound up with maladjustments both in quality and quantity of other essential requisites of the food." [4]

The health of the gastro-intestinal tract depends on the adequate provision in the diet of water, proteins, mineral elements, and vitamins. It is unnecessary to enlarge on the functions of water relative to digestive processes. In regard to proteins it is enough to say that they and their contained amino-acids are the sources from which hydrolytic enzymes concerned in digestion are derived and from which catalytic agents (glutathione, thyroxine, adrenaline, and insulin) are elaborated. As to mineral elements it needs but to recall that they enter into the composition of all cells, including those of this tract, that they control the permeability of cell membranes, the normal contractility of muscles, and

the excitability of nerves, including those of this tract; and, that some enter into the composition of the digestive juices. Their adequate provision is therefore of the first importance to the efficient performance of the functions of the stomach and intestines.

Vitamins of the A, B, and C classes have all a profound relation to the structural and functional efficiency of the alimentary tract. Witness the effect of deficiency of vitamin B1 in impairing the motility of the stomach, with consequent loss of appetite. Witness its effect in impairing gastric secretion and the normal rate of passage of the intestinal residues. Witness the effects of deficiency of vitamin B2 on the health of the lining membrane of the tract. Witness that of vitamin A deficiency in favouring infection of it, an effect which it shares in common with deficiency of vitamin C and of the vitamin B complex. Witness the congestive, haemorrhagic and ulcerative lesions produced in it by vitamin C deficiency. Witness the experimental production by these means in animals of such lesions as gastric dilatation, gastritis, peptic ulcer, enteritis, and colitis (McCarrison, 1918, 1919). Witness the incidence of gastro-intestinal disease, amounting to 25 per cent. of all ailments, amongst insured persons in this country whose diets have so often faults of this character.

## **Diet and Endocrines**

Consider the effects of faulty food on the endocrine glands: the sensitivity of the adrenals to deficiency of vitamins B and C; the sensitivity of the thyroid to deficiency of iodine, of certain vitamins, and of protein, and its reaction to certain excesses in the food, as of fats and calcium; the atrophic changes in the pancreas brought about by carbohydrate-rich and vitamin-poor diets; the functional impairment of the reproductive function due to certain food deficiencies. Food deficiencies, as I pointed out many years ago, derange both the normal production of hormones and the functional perfection of sympathetic nervous control. Consequently, organs such as those of the digestive system are deprived of the full advantage of that efficient regulation and correlation which normally they would derive from healthy endocrine action.

Fifteen years ago I wrote as follows: "Especially do I direct attention to the effects of food deficiency on the digestive organs and on those endocrine organs concerned in the regulation of metabolic processes. These effects provide the pathological basis for attaching to food deficiencies a prominent aetiological significance in regard to that great mass of ill-defined gastro-intestinal disorders and vague ill-health which throngs clinics at the present day, and concerning which we have hitherto known little or nothing." I repeat this passage with the greater emphasis to-day, since the intervening years have provided abundant confirmation of its truth.

## **Obstetrics and Gynaecology**

Contacts of nutrition with obstetrics and gynaecology are many. It will suffice to mention some of them: the impediments which the effects of rickets and osteomalacia may present to parturition; the relations of food, in particular of fats, mineral elements, and vitamins, to fertility, pregnancy, and lactation; the role of linoleic acid (sometimes called vitamin

F) in favouring fertility; the probable effect of fat in facilitating the transference of vitamin A through the placenta to the foetus; the need for an abundant supply of vitamins A, B, and C and of calcium, phosphorus, magnesium, and iron to pregnant and lactating women, and their need for adequate supplies of vitamins D and E and of iodine; the role of vitamin E in preventing habitual abortion; the effects [5] of vitamin A deficiency on the reproductive tract -- vaginal cornification, prolonged gestation, difficult parturition, uterine bleeding, variations in size of the placenta, tissue necrosis of the uterine wall -- effects which in their turn may favour endogenous or exogenous infection. It is true that these effects have so far been observed only in rats, but it is well within the bounds of possibility that they may result in women from similar dietetic causes. It is significant that they occur in rats kept at levels of vitamin A deficiency insufficient to cause xerophthalmia. All these observations indicate the necessity for the proper feeding of prospective mothers, and of pregnant and nursing women: a necessity as much in the interests of the child as of the mother.

## **Surgery and Anatomy**

In regard to surgery little need be said except that the need for it will lessen, certainly in the treatment of internal diseases, when the people learn to feed themselves properly and have the means to do so, and when the profession learns to lead them along the healthful ways of nutrition. The triumphs of surgery -- and who would wish to minimize them? -- are often the defeats of medicine. But as surgery was resuscitated, not so very long ago, by the application of the principles of antisepsis, so will medicine, now so dependent on surgery, be resuscitated by the application of the principles of nutrition. The relation of nutrition to surgical results, to the healing of wounds, to the mending of fractures, and to chronic bone and joint diseases needs no emphasis.

Coming now to anatomy: what relation has nutrition to this? Clearly an important one, especially in regard to the minute structure of the tissues of the body. "For however necessary a knowledge of normal structure of organs and parts of the body may be, it is not less necessary to possess a knowledge of the structural changes induced in them by so fundamental a factor as faulty food." [4]

## **Physiology**

Physiology and biochemistry are so closely interwoven with the science of nutrition that they may be said to be departments of it. Their contacts with it are obvious. To biochemistry has fallen the task of isolating the vitamins: a task it is fulfilling with conspicuous success. There is, however, the risk that in the maze of vitamin and biochemical literature the practitioner of medicine may lose sight of the simple fact that all the body needs for perfect nutrition is provided in the relatively few foodstuffs already mentioned, if these be consumed in proper quantity and in the form in which nature provides them. Then the questions as to what vitamins, what minerals, what other substances, and how much of them are needed by the body are answered for him and more certainly than by biochemistry.

## **Nomenclature**

Here some reference may be made to the nomenclature of the vitamins. These are still spoken of as "accessory food factors," as "anti-this" or "anti-that" deficiency disease. The time has come to disencumber them of these limiting descriptive terms. For they are not "accessories" but essentials, in no way subordinate to the other principles of food. They are substances indispensable to nutrition at every stage in its processes from appetite and the ingestion of food to the evacuation from the body of its waste products; substances without a sufficiency of which normal structure and normal function of organs or parts of the body cannot be maintained; substances as essential to the mechanism of the body as oil is to the mechanism of the car. It is true that they oppose the occurrence of this or that "deficiency disease" -- a term that has also outgrown its usefulness -- but they have, as I pointed out many years ago, much else to do besides the prevention of these maladies, and this much else their greater function.

The main objection to the continued use of these terms is the impression they convey that because there is no xerophthalmia there can be no vitamin A insufficiency, or because there is no beri-beri there can be no vitamin B insufficiency, and so on through the list of "antis." It is the insufficiency, the inadequate ingestion, absorption, or utilization of the vitamins rather than their complete absence from the diet (an exceedingly rare event, even in the case of beri-beri) that is of such importance in the practice of medicine. These terms were well enough as props to a dawning understanding of the role of the vitamins in nutrition. But now that the edifice of knowledge has come to rest on a sure foundation these props are no longer needed.

## **Psychology and Neurology**

Nutrition has a close concern for psychological medicine and neurology.

"The rapid growth of the brain and the development of the nervous system render the growing child peculiarly susceptible to nervous disturbances, whenever conditions of life are such as to interfere with normal nutrition. Most of the neuroses of childhood depend entirely upon disorders of nutrition. The headaches, insomnia, disturbed sleep, chorea, habit-spasm, hysterical manifestations, and a multitude of others are relieved only by correcting the faulty diet and habits which are the basis of the disturbed nutrition." (Holt).

The relation of nutrition to intelligence and backwardness in schoolchildren, the mental disorders in pellagra, the interdependence of physical and mental conditions, are other examples of the contacts of nutrition with psychological medicine.

It is now definitely known that deficiency of vitamins A, B1 and B2 has important relations to the development and health of the nervous system. A striking example of this truth is that afforded by the tissue-culture work carried out at the Nutrition Research Laboratories, Coonoor. There it was found that embryonic nerve tissue failed to grow normally in the plasmas of animals deprived either of vitamin A or of vitamin B. Among the effects on the nervous system of vitamin deficiencies are non-inflammatory

peripheral neuritis; degenerative changes in the brachial plexus, sciatic nerves, sensory tracts in the periphery of the spinal cord, posterior columns and posterior nerve roots, Gasserian ganglion, and less commonly in anterior nerve roots and vagus. The nerve changes often present in pellagra in man as well as the association of vitamin B1 deficiency with beri-beri, with some cases of neuritis in pregnancy and, possibly, with alcoholic neuritis, are familiar examples of the contacts of nutrition with neurology.

In the field of ophthalmology the relation of night-blindness -- of which there appear to be minor degrees more common in Western countries than was formerly supposed -- xerophthalmia, and keratomalacia, to deficiency of vitamin A, is now well established. In connexion with it it may be recalled that the changes brought about by it in the conjunctiva appear to confer pathogenic characters upon otherwise harmless saprophytes present thereon; changes in the soil seem to alter the characters of the seed.

## **Orthopaedics and Radiology**

Orthopaedics has contacts with nutrition that are exemplified in the results of rickets and osteomalacia. The fragility of bones, spinal curvature, displacement of vertebrae, diseases of joints, slow and imperfect mending of fractures, all caused, or possibly caused, by faulty nutrition, are other examples of these contacts. Here mention may be made of a case of spondylolisthesis, in a child of well-to-do parents, that lately came to my notice: an example, as it proved to be, of malnutrition in the midst of plenty and of the truth that it is not the food presented to a child but the food eaten and utilized that is of importance. In this case operation by bone-grafting was suggested for the correction of the deformity: a suggestion fortunately not followed; for the child made a complete recovery, as evidenced by an x-ray examination, after a year's proper feeding combined with properly directed exercises.

It is in such cases as this and in the detection of rachitic and other bony changes which might otherwise escape observation that radiology comes into touch with nutrition. Physical medicine does not, at present, appear to have any direct contacts with nutrition, yet the use of physical methods in endocrine disorders and in certain maladies that may have a malnutritional basis may not be without significance.

## **Oto-rhino-laryngology**

Nutrition has a close concern for oto-rhino-laryngology, particularly in view of the changes brought about in mucous membranes by deficiency of vitamin A. These changes, which I shall have the opportunity to demonstrate to you this afternoon, are such as break down the local defences against infection, and may be of localized or widespread distribution. It is common knowledge that malnourished, weakly, and ill-conditioned children are peculiarly susceptible to inflammatory states of the nose, ear and throat. "It is almost impossible in winter to keep [such children] in a hospital ward more than a week or two without their developing rhino-pharyngitis, otitis, bronchitic or broncho-pneumonia" (Holt): a state of affairs recalling the "hospitalism" of the dark days of surgery prior to the advent of Lister. Such children frequently suffer from adenoids,

which may possibly have a malnutritional basis, for I have myself observed the development of adenoid-like outgrowths in the upper respiratory passages of improperly fed rats.

## **Tuberculosis and Dermatology**

Concerning tuberculosis and nutrition, one example will suffice: at the Papworth Village Settlement no child born there during the twenty years of its existence has, while a member of the community, contracted tuberculosis of the lungs, bones, joints, cerebral membranes, nor indeed any clinical form of the disease. Yet these children are the offspring of parents who suffer from tuberculosis and are in constant contact with them. How has this remarkable achievement been brought about?

1. By adequate nutrition, which maintains the child's resistance to infection, and
2. by the absence of mass dose infection -- procedures which will prevent many other diseases besides tuberculosis.

Here it is necessary to emphasize the relation of faulty nutrition to respiratory disease in general. It is a significant fact that one out of every ten sick persons amongst the insured classes in England and Wales suffers from such disease, and that rats fed on a diet in common use by these persons frequently develop such disease. Deficiency of vitamin A is particularly concerned in bringing this about.

In the domain of dermatology the effects of faulty nutrition on the skin are well recognized; semi-starvation, water deficiency, protein deficiency, mineral deficiency (particularly of iron, calcium, phosphorus, and iodine) and vitamin deficiency (particularly of vitamins A, B, and C) all have harmful effects on this organ and its appendages. Amongst them are dry and inelastic skin, roughening, atrophy, laxness, wrinkling, slow growth of hair, staring hair, loss of hair, slow healing of skin wounds, poor and imperfect cicatrices, furunculosis, ulcers, exudative skin diseases such as eczema and seborrhoea, the skin lesions of pellagra, oedema, xerosis, abscesses, inflammatory conditions at muco-cutaneous junctions, the papular condition known as "phrenoderma," hyperkeratosis, petechial haemorrhages and other scorbutic skin affections.

## **Therapeutics**

It is in the domain of therapeutics that the newer knowledge of nutrition finds scope for practical application. "Formerly, in planning the patient's food, physicians thought solely in terms of the local pathological condition, of the harm they might do some impaired organ; now they think chiefly in terms of general physiology, of the good they can do the patient as a whole" (McLaster). It is in most cases the patient who must be treated rather than the disease from which he suffers, and in this treatment nothing is so important as maintaining nutrition. Witness the changes that have come about within recent years in the treatment of such conditions as typhoid fever, gastric ulcer, Bright's disease,

hypertension, diabetes, tuberculosis, chronic arthritis, and eclampsia: a change based on the fundamental principles of the correction of food faults and the provision in proper amounts and proportions one to another of the various food-essentials needed for the maintenance of structure and function of organs or parts of the body.

In the last resort the patient must, with remarkably few exceptions, heal himself, and it is by adequate nutrition that he can best be put in the way of doing so. Here the newer knowledge comes to the aid of the physician, enabling him, by means of refined preparations, rapidly to satisfy the needs of the body for substances that are in default, and thus to hasten cure.

## **Medical Sociology**

The importance of nutrition in medical sociology is evidenced by the programme of work before that Section at the present Annual Meeting, wherein it is given a prominent place; it will, then, speak for itself. But I am constrained in this connexion to refer again to the remarkable experiences of the late Miss Margaret McMillan mentioned in her book -- *The Nursery School* (1930). Here she has described the weakly, ill-nourished, and ill-conditioned children of the slums who come for admission to the nursery school at Deptford: children who are rachitic, and bronchitic; children with inflammatory states of the nose, ear and throat; children who have adenoids and dental caries. After they have been nurtured and properly fed for a few years they are, she says, almost all cured of any ailments from which they may have suffered on their entrance to the school. They are all straight and well grown, the average child is well made with a clean skin, is alert, sociable, and eager for life and new experience... "He does not need to see the doctor or the dentist, and he has none of the minor ailments which affect the children of the slums."

Surely, we have in experiences such as this the root of the whole matter. We now know that large numbers of our people have not the means wherewith to provide themselves with proper food even though they had the knowledge to enable them to judge of what is proper; a state of affairs damnatory of our civilization. But it would be wrong to suppose that poverty is the only cause of faulty nutrition. "Access to abundance of food does not necessarily protect from the effects of food deficiency, since a number of factors -- penury, prejudice, ignorance, habit -- often prevent the proper use and choice of health-giving foods." [4] To these impediments to normal nutrition I would add indifference, neglect, and the weak indulgence of their children by many well-to-do parents which fosters tastes and habits detrimental to normal growth, nutrition, and health.

Education of the people, the better education of ourselves: these are urgent necessities. It may be that the medical curriculum is already overgrown. If so, let it be pruned, let us teach the student less about "disease" and drugs and more about "health," more about nutrition, which is the very basis of health.

## **Medical History**

I come now to the last of the Sections -- that of the history of medicine. In this history no chapter is more romantic, more inspiring, more replete with hope for the future of our calling and for the well-being of mankind, than that dealing with the newer knowledge of nutrition. Its opening pages tell of the dawning idea of the relation of certain diseases, notably scurvy and beri-beri, to defects in food. These are succeeded by others describing the discovery of vitamins. As the story unfolds the numbers of these and of other elements and complexes, found to be necessary for normal nutrition, increase, and the conception of disease as a manifestation of disturbed structure or functions of the body consequent on faulty feeding and on the faulty nutrition resulting therefrom comes into being. Patient research, the discovery of facts, generalizations from facts, the prediction of fresh facts -- its pages tell of these. These are the ways of science; these the ways in which the science of nutrition has been built up.

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