Remarks

ON

DISEASES OF FAULTY NUTRITION.*

BY

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[AFTER observing that the functions of food were to rebuild the living tissues, to supply energy, and to preserve a proper medium in which the biochemical processes of the body could take place, Colonel McCarrison said that the failures of food to subserve these functions were brought about in a number of ways; that with which he would deal was the insufficient proportion of one or other of all three of the essential constituents of a diet—namely, suitable protein, inorganic salts, and vitamins. The first effect of such unsatisfactory foods was a low standard of physical efficiency; this prevailed in many parts of India, both in man and his domestic animals; minor manifestations of ill health might thus be produced which might escape observation, although, as Hopkins had said over twenty years ago, they “affect the health of individuals to a degree most important to themselves.” In animals this subnormal nutrition was shown by loss of “condition,” and by impairment of fertility and of the power to rear their young, which were prone to disease and had a high mortality. If the deficiency was more pronounced distinct disease was produced in man, such as keratomalacia, night-blindness, dental caries, polyneuritis, beri-beri, pellagra, scurvy, rickets, osteoporosis, slow healing of fractures, sterility, anaemias, some types of goitre, alimentary dystrophy, gastric atony, diarrhoea, constipation, intestinal stasis, colitis, unhealthy skin, disordered action of the adrenal glands, stone in the bladder, and vesical irritability. In domestic animals likewise there was a long list of disease conditions attributable to this cause; they were recognized by veterinarians to be due to deficiency in the diet, especially in mineral elements.]

The relation of malnutrition to disease had many aspects, and progress in its comprehension depended on the closest co-operation between students of human, of animal, and of plant nutrition. The fact that one of the most important means by which disease is brought about, both in man and animals, was by increasing susceptibility to infectious agents was illustrated by the following statement:]

During the past two and a half years 2,463 rats, living in my laboratories under conditions of perfect hygiene, have been fed on various faulty foods, while the daily average of control or well-fed stock rats was 865. The mortality in the ill-fed animals (excluding those that were killed on the conclusion of certain experiments) was 31.4 per cent., while in the well-fed animals it was less than 1 per cent. Of the former 13.5 per cent. died of lung diseases, chiefly pneumonia or broncho-pneumonia, while only 0.63 per cent. of the latter died from the same cause. Of the ill-fed animals 3.3 per cent. died of acute gastro-intestinal disease; of the well-fed only 0.09 per cent. During the same period 1,252 previously healthy pigeons were fed on various diets deficient in vitamins, the average number of stock or control well-fed birds being 331. Of the ill-fed birds 5.8 per cent. died of heart disease, chiefly pericarditis, while of the well-fed birds only 0.06 per cent. died from this cause; these figures being exclusive of 137 birds which developed true beri-beri with its accompanying heart disease. In the course of my own work I have seen true dysentery arise in ill-fed monkeys, while well-fed monkeys living in the same animal room escaped; and I have seen ill-fed pigeons become infected with *Bacillus suispestifer* and with the invisible virus of epithelioma contagiosum, while well-fed birds living in their immediate vicinity escaped these infections. The bacillus of mouse typhoid kills, on injection, over 90 per cent. of ill-fed mice, while it kills less than 10 per cent. of well-fed mice; the ill-fed mice are likewise less resistant to *B. pestis caviar* and to *botulinus* toxins. Birds are rendered susceptible to infection by anthrax when fed on food deficient in vitamin B, and rats to septic broncho-pneumonia when fed on food deficient in vitamin A; guinea-pigs, when fed on food deficient in vitamin C, die more readily from tuberculosis; ill-fed calves develop interstitial nephritis due to *B. coli* infection; swine suffer from tuberculosis, which can be eradicated from the herds by well-balanced vitamin-rich food; stock animals develop sarcosporidia from the same mal-nutritional cause. Man himself provides many examples of a like kind; I need but mention two: in northern Melanesia the native

diet has been shown to be deficient in suitable protein, mineral elements, and vitamins, and the poor physique of the natives and their high death rate from respiratory and intestinal diseases have been correlated with these deficiencies in the food; outbreaks of broncho-pneumonia in children have been definitely traced to the inadequate ingestion of fat-soluble A, and have been caused to disappear by the adequate provision of this vitamin. There is good reason for the assumption that tuberculosis, leprosy, cholera, dysentery, plague, and malaria have often in India a mal-nutritional element in their genesis and course.

The following passages are taken from the concluding section of the paper.

Within recent years “the spectacular results which have attended the experimental study of vitamins have overshadowed much else in nutrition, both in the minds of the profession and the public” (Mendel, 1923). It may not be inappropriate, therefore, to refer to a class of disease which results from the lack of balance of various components of the food, each component in itself good. One example of the kind is afforded by the hyperplastic goitre which may result from an excess of butter in the food. The excess of butter, or of unsaturated fatty acid, causes thyroid hyperplasia by reason of the relative deficiency of iodine brought about by this excess; similarly, enlargements of the thyroid gland of the colloid type may be induced by an excess of lime; they are preventable by increasing the iodine ingested proportionately to this excess. Another example of much the same sort is that of stone in the bladder, which is brought about in rats by ill-balanced diets containing much oatmeal, whole-wheat flour, or white flour. To avoid “stone” the excess of these cereals must be compensated for by the consumption of appropriate amounts of milk. Those most excellent foods oatmeal and whole-wheat flour—the staple articles of diet of such vigorous races as the Scots and the Sikhs—may likewise prove harmful, by causing disturbance in the normal processes of calcification, when—but only when—the diets containing them are poor in vitamin D. These cereals are not in themselves complete foods; a fact of which the races using them as staple articles of diet are not wholly in ignorance—the Sikh does not attempt to subsist on *atta* (whole-wheat flour) alone, nor the Scot on oatmeal. Any ill effect which these two foods may exercise is due to the failure suitably to combine them with other food materials which compensate for their defects. They are not to be condemned nor to be displaced from their prominent place in the dietaries of mankind for this reason. As well might we condemn the good fuel, petrol, for the overheating of the engines of our cars when we fail to supply them with sufficient oil, as to condemn the excellent wheat and oats when we fail to consume with them sufficient quantities of milk or other vitamin-rich foods, which are required by the human machine for its smooth and efficient running.

The same kind of misunderstanding surrounds the controversy which periodically rages over the relative values of white bread and bread made from whole-wheat flour. Both are excellent foods, though neither is a complete food; and since man requires a certain amount of suitable protein, of mineral salts, and of vitamins as well as of carbohydrates, the superiority of the one bread over the other, as the staple article of diet, lies in the extent to which it excels as a source of these essentials. Seeing, therefore, that white bread is notably more deficient in suitable protein, in vitamins (both A and B), and in certain essential salts, than bread made from whole-wheat flour, or, indeed, than any other single food entering into the dietaries of Western peoples—with the exception of sugars, starches, and fats which are marketed in the pure state (McCollum)—it is by this much the poorer foundation upon which to build a well-balanced diet. Those who can afford to build upon it, and who possess the requisite knowledge to build wisely, have little need to fear nutritional ailments, though their building is improvident, while those who cannot—and there are millions of such—are in grave danger of disease. Next, then, in importance to the quality of the various ingredients of our food is their right combination.

In experiments on rats I found that the well-balanced vitamin-rich diet of the Sikhs is superior to any synthetic diet I can devise, and to which vitamins in the form of yeast and cod-liver oil are added. I do not believe that human beings can have too much vitamins when they

* Extracts from a paper opening a discussion on the subject at the seventh Congress of the Far Eastern Association of Tropical Medicine in Calcutta, December, 1927.

are taken in the form in which Nature provides them in well-balanced combinations of unsophisticated food materials. Some individuals appear to require more vitamins than others, size being an important factor in determining their requirements; some species of animals require more of a particular kind of vitamin than others; more are needed for reproduction than for growth, and more for optimum well-being than for the prevention of the named deficiency diseases; more are required by the lactating than by the non-lactating animal, and more for longevity than for a shorter life. The amount needed varies with the composition of the food, with its balance in other essentials, and with its digestibility; more of one vitamin is required when the food is very rich in another—as, for instance, more vitamin C when the food is rich in vitamin D; there is for optimum nutrition an ordered balance even amongst the vitamins themselves. In short, the amount of vitamins needed varies with the metabolic requirements of the individual; the attainment and maintenance of physical perfection, heavy work, reproduction, lactation, digestion, exposure to cold, infectious and debilitating diseases, are all indications for their liberal supply.

Before bringing this brief survey to an end I will refer to another aspect of the matter: the effect of vitamin deficiency in increasing the susceptibility to certain poisons, which the work of Smith, McClosky, and Hendrick has recently brought into prominence. Deficiency of vitamin A increases the susceptibility of mice to *botulinus* toxin, and also their susceptibility to mercuric chloride. Deficiency of the same vitamin induces in rats an enormously increased susceptibility to morphine, to ergotoxine, and, in lesser degree, to histamine. Deficiency of vitamin B like-

wise increases greatly the susceptibility of rats to ergotoxine and to pilocarpine. Stimulants of the central nervous system are all more toxic to rats receiving too little vitamin A than to well-fed animals.

Observations of this kind suggest that the ability of the tissues to detoxify certain poisons—both bacterial and other—is reduced by diets deficient in vitamins; while indicating that such diets increase the sensitivity of the nervous system and of its autonomic division to toxic agents. Not only may this be so, but the disturbances of metabolism which result from vitamin insufficiency may themselves give rise to toxic metabolites which exercise specific effects on certain organs and tissues of the body. This I believe to be the case in beri-beri. Most of us will probably agree that there is such a thing as a specific beri-beri-producing poison, though disagreeing as to whether it be produced in rice before this food is ingested, or in the intestine by some bacterial agent introduced with rice, or in the course of a disordered metabolism arising out of vitamin insufficiency. Our disagreements will not greatly matter so long as we recognize the prime importance of a sufficiency of the antineuritic fraction of vitamin B in preventing beri-beri.

The newer knowledge of nutrition is, I am convinced, the greatest advance in medical science since the days of Lister. When physicians, medical officers of health, and the lay public learn to apply the principles which this newer knowledge has to impart, when they know what malnutrition means, when they look upon it as they now look upon sepsis, and learn to avoid the one as much as they now avoid the other, then will this knowledge do for medicine what asepsis has done for surgery.

PERNICIOUS ANAEMIA TREATED WITH LIVER DIET.

BY

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THE following case appears to be of some interest in view of the severity of the symptoms, the age of the patient, and the rapidity of the improvement with liver diet after a prolonged course of arsenic had failed to produce appreciable alteration in the blood count.

A widow, aged 68, had had no severe illness, though always delicate. She had undergone hysterectomy (with ? double ovariectomy) at the age of 35, and had taken $1\frac{1}{2}$ grains of thyroid extract daily for fourteen years for myxoedema. Her husband died three years ago; she had a "nervous breakdown" two years later, and was put on tablets of iron, arsenic, and strychnine for anaemia; these she took on and off until January, 1926.

In July, 1926, numbness and tingling of both feet with oedema occurred, and gradually extended up the legs. In January, 1927, she presented a very definite yellow tinge, complained of morning nausea, severe yellow-coloured diarrhoea, weakness, and breathlessness. The lips and mucous membranes were pale.

A blood count done by the Laboratories of Pathology and Public Health on November 12th, 1926, was as follows:

Red cells ...	1,670,000	Small mononuclears ...	39 per cent.
White cells ...	7,000	Polymorphonuclears ...	53 "
Haemoglobin ...	45 per cent.	Large mononuclears ...	6 "
Colour index ...	1.36	Eosinophils ...	2 "

Poikilocytosis markedly present.
Anisocytosis and polychromasia present.

The blood pressure was 162/62. The heart and lungs were normal, the reflexes slightly exaggerated. There were no retinal haemorrhages. The urine was normal in colour and contained no albumin or sugar.

The removal, in January, 1927, of septic lower incisor teeth and a septic molar was followed by temporary improvement in her clinical condition. In April she had an attack of cystitis which necessitated treatment for ten days.

From May to September, 1927, she was taking arsenious acid tablets (gr. 1/20 twice daily after food), but although the clinical condition had improved somewhat, a blood count done on September 10th by the same pathologists showed no improvement.

Red cells ...	1,670,000	Small mononuclears ...	43 per cent.
White cells ...	2,500	Large mononuclears ...	5 "
Haemoglobin ...	45 per cent.	Polymorphs ...	50 "
Colour index ...	1.30	Eosinophils ...	1 "
		Mast cells ...	1 "

The red cells showed moderate variations in size, large average size; there was moderate poikilocytosis, slight polychromasia, and no abnormal white cells.

She was first seen by me on September 20th, 1927, and was then very yellow, weak, and breathless on exertion; she complained of palpitation, sore tongue, eructations after food, and tingling and numbness of the feet. The tongue was "beefy," dark red, and tender, the lips and mucous membranes pallid. There was a slight systolic murmur at the apex. There was no oedema of the feet, but cutaneous anaesthesia, both epicritic and protopathic, of both feet and legs up to the thigh. Heat and cold were well appreciated. The knee-jerks and ankle-jerks were normal, the plantar reflexes flexor; the skin over the feet was dry and atrophic. Vibration was appreciated in the tibiae.

A blood count by Dr. J. Bamforth of St. Thomas's Hospital, on October 11th, was as follows:

Total red cells ...	1,910,000	Polymorphs ...	38 per cent.
Total leucocytes ...	2,080	Small lymphocytes ...	44 "
Haemoglobin ...	42 per cent.	Large lymphocytes ...	8 "
Colour index ...	1.1	Eosinophils ...	2 "
		Large hyalines ...	7 "

There was much poikilocytosis and anisocytosis. Punctate basophilia was present; megaloblasts found. The blood count corresponded in all particulars with that of a true pernicious anaemia.

For a fortnight before the taking of this blood count the patient had been so weak and ill, and complained so bitterly of persistent diarrhoea, that the arsenic had been suspended and she was having only dilute hydrochloric acid (m xv thrice daily). She was then extremely weak and ill, and was only capable of leaving a sofa for meals, which was a necessity.

On October 11th a diet containing 7 oz. of calf's liver per diem was given, partly as raw sieved pulp and partly as cooked liver. The raw liver (4 oz. sieved weight) was given mixed with half a cupful of orange juice with water added, and taken at 11 a.m.; the cooked (3½ oz. fried) liver was taken as the evening meal with a rash of bacon. Fresh fruit and vegetables were recommended and fats other than the bacon and butter were forbidden. Ostelin tablets (one thrice daily after food) were prescribed, the rest of the diet being to taste. At the end of a fortnight from the commencement of treatment improvement became evident. The lips were redder and the yellow tint paled. She was then able to walk freely about the room. Diarrhoea ceased, and she has since continued to improve. The cheeks are now no longer pallid.

On November 22nd a further blood count by Dr. Bamforth gave the following result:

Total red cells ...	5,580,000	Polymorphs ...	68 per cent.
Total leucocytes ...	7,200	Small lymphocytes ...	17 "
Haemoglobin ...	72 per cent.	Large lymphocytes ...	2 "
Colour index ...	0.65	Large hyalines ...	4 "
		Eosinophils ...	8 "
		Mast cells ...	1 "

No poikilocytosis or anisocytosis.

At present (December 2nd, 1927) the patient is apparently in good health, though thin; her appetite is not good, the lips and mucous membranes are no longer pale, the lemon tint has almost entirely disappeared.