NUTRITIONAL SCIENCE AND PRACTICAL DIETETICS*

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The study of nutritional science may be firstly an end in itself; that is, it may be part of the search for knowledge for its own sake. Secondly, nutrition may be studied scientifically in order to assist the farmer in getting the best yield for his investment of capital and labour; in other words it may be part of the study of agricultural and veterinary practice. Thirdly, the discoveries of nutritional science may be applied to the practice of curative and preventive medicine; that is it may be part of medical science and practice. In this objective practical dietetics becomes an important vehicle of application.

In South Africa at least the application of nutritional science to agricultural and veterinary science got a start of two or three decades on its application to medical science and preventive medicine in the human being. In the late 1930s, when the South African Nutrition Council had its inception, the statement became a *cliché* that far more money and thought and work had been put into methods of feeding cattle, sheep and poultry than had been put into improvement of the diet of the South African population. This statement was undoubtedly correct and it is interesting and instructive to analyse the reasons for the paradox.

To begin with, the Onderstepoort Veterinary Research Station was already known in many parts of the world while the South African medical schools were still in their infancy. The personnel of the Union Government's excellent veterinary service were largely trained at Onderstepoort and they constantly brought or sent back to Onderstepoort the problems with which they were faced in the field; many of these were related to animal nutrition, and the problems presented to the staff of Onderstepoort stimulated a large body of fruitful research in animal nutrition.

NUTRITION IN MEDICINE THIRTY YEARS AGO

On the other hand the majority of medical practitioners in the country and a large part of the staff of the South African medical schools had been trained in Britain or Western Europe in an era when applied human nutrition received scant notice in medical education. I was fortunate in receiving my training in the pre-medical sciences in that remarkable school of animal physiology headed by Sir Charles Sherrington in the University of Oxford. This school included a department of biochemistry headed by Sir Rudolph Peters. I recall the personal demonstration, by Peters himself to the class of my year, of the dramatic correction in a few moments of the head retraction and paralysis in the B1-deficient pigeon by the injection of thiamine. My education in physiology in Oxford included *mirabile dictu* a visit with my tutor to the school of biochemistry headed by Sir Gowland Hopkins at Cambridge. Nutritional science was dominated at that time by vitaminology, and vitamins constituted a considerable part of my physiological thinking even in the Oxford school which, under Sherrington, was understandably orientated principally towards neurophysiology. Of course vitamins were considered against a background of protein, fats, carbohydrates and calories. We talked about first-class protein and second-class protein and knew that proteins were broken down in the gastro-intestinal tract through polypeptides to amino acids. But even though vitamin fortification of foodstuffs and vitamin therapy in medicine were familiar ideas, I cannot remember anybody even thinking about the possibility of improving the biological value of second-class proteins by fortification with synthetic amino acids. Fats were just fats but I can recall clearly being intrigued at the time by the earliest reports on the roll of essential fatty acids and thinking that this should be a fascinating and fruitful subject for research. That idea, however, went to bed in my mind until 30 years later, when work initiated in my own department by Dr. B. Bronte-Stewart helped to bring quite suddenly a new interest in the possible role of essential fatty-acid deficiency in human disease. On the other hand I did see clearly at that early stage one wrong trend which we have not yet put right. In an essay on protein requirements I criticized the unjustified conclusion that because C. Voit had found that the average German working man consumed approximately 118 g. of protein per day this must be the human requirement for protein. Nutritionists today however are still making the same type of error, perhaps most noticeably in recent years in the American recommendation of 75 mg. of ascorbic acid per day.

The salt composition of the body was studied and it was recognized that there were trace elements detectable by the spectrograph which might have some functional significance. The modern interest in trace elements as essential components of enzyme systems was, however, not even contemplated.

While I was studying nutritional science as part of my physiology at Oxford the principles of nutritional physiology were being applied, particularly under the influence of Onderstepoort, to the production of better milk yields in cows, of better egg-laying in hens, and of quicker growth in piglets, while *styfsiekte* had already been abolished by the recognition of phosphorus deficiency in pastures as its cause and its correction by artificial phosphates or bone meal. From Oxford I went for my clinical training to the London Hospital. I suppose that 'The London' was as well orientated towards dietetics in medicine as any English medical school because it had on its staff that redoubtable figure Robert Hutchison, who recently wrote the foreword to the 13th edition of the book on dietetics which he had first published 51 years before. Certainly we were lectured on dietetics by this lugubrious-looking but remarkably entertaining Scot. The London had a metabolism ward in which diabetes, osteomalacia and other disorders were studied and dietetic principles applied to the correction of illness. But I never heard any talk about applying nutritional science to the prevention of disease or to the achievement of good and lasting health except in the sphere of infant feeding. Apparently the contents of the baby's bottle were important to its welfare; certainly it might require orange juice, cod liver oil, and perhaps some iron, to tide it through to the period of mixed feeding, but after that it was tacitly assumed that, at least among the privileged, appetite would lead to good nutrition except in rare instances of anorexia nervosa. These deficiencies in the clinical educa-

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tion of my generation of medical students in London have doubtless long since been corrected but old traditions of thought die hard. I recently reviewed that truly remarkable book 'The Diseases of Occupations' by Donald Hunter, a London Hospital physician. I owe very much to my late chief in stimulus and in enthusiasm; I recall his talking to us as students about the sound of cattle 'crunching bones on the South African veld' before I, a South African, had heard of aphosphorosis or *styfsiekte*. In spite of my admiration for him and for his book I was constrained to point out in my review that the word 'nutrition' appears on only one page of the index and the words 'food' and 'diet' do not appear at all. I pointed out that in South Africa and in many parts of the world malnutrition is the greatest and most easily preventible occupational hazard, being a hazard of migrant labour.

Invalid Dietetics

In those days dietetics in medical education consisted in the use of invalid foods and invalid diets. Many of the latter were applied then, and even until quite recently, without any appreciation of the requirements for the maintenance of nutrition. The Sippy diet, for example, was applied for decades to the treatment of peptic ulcer although it was calorically deficient and nutritionally unbalanced. Avitaminoses reproduced by diabetic diets were prevalent, while convalescent pulmonary tuberculotics struggled around under a great mound of obesity produced by applying the calorie requirements of an active labourer to a man lying recumbant in bed for six months or a year. So prolonged was the hold of the Sippy diet that Meuelengracht of Copenhagen was constrained to break its caloric and nutritional inadequacy by a quite unnecessary swing of the pendulum to minced beefsteak for immediate application, by force if necessary, to the management of haematemesis.

Reasons for Neglect of Human Nutrition

1. *Simplicity of Objective.* Why was nutritional science so neglected by the medical profession when its importance was so clearly recognized by veterinarians? Why were the principles of dietetics in medical practice applied only to infant feeding and with such absurd perversions to invalid diets? Why did the veterinarians teach the farmer that it was worth while to feed his animals properly while medical educators thought the subject unworthy of discussion? Undoubtedly part of the answer lies in the comparative simplicity of objectives in animal husbandry. The farmer knows what he wants. In his cow he wants better milk production over a longer period without undermining of health. From his hen he wants a daily egg for a longer period of days, from his pigs and poultry he wants growth to marketable size in the shortest period of time. His objectives are indeed simple. Who can say on the other hand what is the objective of human feeding? Stated in general terms, it should presumably ensure optimum growth and development, maximum resistance to wear and tear and infection, and maximum life expectation. Certainly none of these desirable objectives should be limited by insufficient or by ill-balanced food, but can these general objectives be translated into practical diets in widely different regions of the world and to widely differing tastes? To civilized peoples eating is more than the satisfaction of hunger and supply of bodily needs; it is also a social grace. If all healthy foods are provided to satisfy demand can the appetite be regarded as a reliable guide? Unfortunately the prevalence of gluttony and obesity suggests that appetite is not a reliable guide. The culinary art and the enterprise of food technologists have so transformed the appearance and taste of natural foodstuffs that appetite has lost its path as a guide to health; so public education in health and nutrition is a definite necessity. In this the dietitians have their most valuable opportunity.

2. *Curative Orientation.* But it is doubtful whether the comparative simplicity of objectives was the whole reason for the greater application of nutritional principles to animal than to human nutrition. Another reason is that medical education was still largely curative rather than preventive in its orientation. The patient paid his doctor to diagnose and cure his malady, not to prevent disease. The farmer on the other hand looked to the veterinarian for guidance in health promotion in his herds; except with a stud animal it was easier and cheaper to kill the sick beast than to try to cure it.

THE NINETEEN-THIRTIES

Minimum Requirements and Recommended Allowances

At the time between the first and second world wars, when the application of nutritional principles to disease prevention and health promotion was still largely neglected by practising physicians, there were far-sighted pioneers who saw its value. Sir John (afterwards Lord) Boyd Orr was one; Sherman and Rose were notable in the United States.

The interest among nutritional physiologists and those concerned with health promotion led to the study of minimum requirements and the laying down of recommended allowances. The latter were supposed to provide a margin of safety between actual intake and minimum requirement which would be adequate for the common stresses. The margin was usually set fairly wide, seldom less than 50% in excess of minimum requirement. This was done on the principle that, at least for vitamins, minerals and essential amino acids, it was better to give too much rather than too little. This margin of safety need not be criticised provided the minimum standard really was a minimum. Unfortunately the setting of the minimum standards and recommended allowances were sometimes based on two principles which will not bear critical analysis, viz. (1) that the amount required to establish equilibrium in a balance experiment is the minimum or desirable requirement, and (2) that because healthy well-nourished people in a privileged community chose to eat enough of a nutrient to achieve equilibrium their choice indicates a requirement of some sort. The acceptance of the latter principle in relation to protein requirements 50 years or more ago has already been criticized. Its counterpart in the 1930s led to the setting of recommended intakes of calcium and ascorbic acid which most of us feel today were unnecessarily high. Nevertheless these recommendations have doughty supporters. I was present at a meeting of the Food and Nutrition Board in Washington, USA when a very influential sub-committee moved to reduce the recommendation for ascorbic acid from 75 to 50 mg. per day for adults. Although the sub-committee's report was unanimous it was challenged so vigorously and with such impassioned oratory by one member of the Board that the reduction was rejected. I was informed that a similar reduction in the recommendation for calcium would probably meet with a similar rejection.

This attitude was undoubtedly a by-product of the American 'era of plenty' to which I shall shortly refer. In the case of calcium there is little doubt that efforts to implement the recommendation by nutrition educationists and dietitians led to the phenomenal consumption of milk and dairy products by adults in the USA—a trend which almost certainly in turn led to the very high fat/calorie ratio of modern American diets. I well remember an episode which I observed in a Washington Club: A young couple were evidently celebrating an anniversary (a baby-sitter had doubtless been engaged). After a good dinner and a bottle of wine I was horrified to see them order a glass of milk each (shades of the French wine industry)! It made me feel nauseated!

The Rise of Dietitions

The 1930s also saw the rise, although not the beginning, of the dietitians. They had been trained and employed for managing special diets and therapeutic menus in hospitals. But as recommended allowances appeared they were required more and more for interpreting these allowances into food purchases for many types of institutions. They have served in this respect a most valuable function and the need for their services is likely to increase steadily, or even rapidly, now that clinicians are belatedly accepting the importance of nutrition research for medical progress.

Food Industry

In the same decade before World War II, Food Industry, particularly in the USA, was awakening to the possibility of sales promotion by health education and was beginning to expend its huge profits in research. These profits doubtless derived from the need for simplification in cooking as domestic servants became scarcer and scarcer under the influence of America's enlightened application of education to the masses and of her expanding economy. The American housewife came home to her apartment after a day's work and wanted to be able to get dinner on the table without the tedious chores of the kitchen. She had to get her children off to school and her husband and herself off to factory or office with a comfortable stomach and an early start. Out of these needs the ingenuity of sales promoters evolved the processed, pre-cooked and packaged foods—the breakfast cereals, the pre-cooked oatmeal and the frozen orange juice for breakfast and the tenderized boned steak, frozen vegetables and choice ice cream for dinner. With a huge population, a rapidly expanding economy and enterprising advertising these developments began to lead to vast profits and stern competition. Advertising agents began to comb the nutrition files and badger research workers for advertising copy. What could be better copy than 'food for health'. The American family drooling over the luscious colour pictures of food in their magazines was told that all these attractive things were healthy. The era of 'Popeye the Sailor Man' had come and by the time more critical minds had debunked the alleged special virtues of spinach, successors had arrived to carry the imaginative public to foods even more attractive and healthy. The depression of the early 1930s gave the programme a set-back but by the late 1930s the lost ground was more than recovered.

Food Surpluses and Outlets

Then came the era of farm surpluses; the first Roosevelt Administration kept the farmers sweet with 'farm subsidies'. Outlets had to be found for surplus butter, eggs, dried milk and frozen meat. Domestic outlets were found in subsidized food for schools, hospitals, orphanages and crèches. But these subsidized gifts must be rationalized—they could not be fobbed off as mere charity; they must be presented as 'health-giving for the nation', and so came the era of superabundant food—let no one suffer from the remote possibility of a sub-optimum diet; pile on the calories, pile in the vitamins, the minerals and the trace elements; let them all come. The kidney will get rid of any excess.

I have described this process as occurring especially in the United States and undoubtedly this was so. Comparatively speaking, other countries lagged behind and the medical profession was still largely indifferent, outside of the USA, to diet as a means of health promotion.

The Start of the National Nutrition Council

In 1938 I returned to the University of Cape Town after 13 years abroad during the last 6 of which I had been actively engaged in nutrition research at the Harvard Medical School and the Universities of London and Cambridge. The Nutrition Council and its Research Committee had just been instituted, I believe through the imagination of Dr. E. H. Cluver, at that time Secretary for Health. It appeared then that most of the knowledge had already been laid for a nutrition programme; all that was needed was better health education and increased farm production.

Those of us who took an active part in the work of the Council were regarded as 'a little peculiar' by our medical colleagues. Food was a matter for administrators and politicians, not for physicians and certainly not for medical research workers. Castle writing in 1952 of his chief, the late Dr. G. R. Minot, says: 'He was accustomed to extract the smallest details of the dietary history of patients with pernicious anaemia on the wards of the hospital in 1922. This was considered by callow interns like myself to be on the whole an amiable eccentricity of an otherwise sound clinician. In this way he established to his personal satisfaction that persons with pernicious anaemia often lived on one-sided diets for many years prior to their illness and sometimes developed a disgust for meat at its onset.'

THE SECOND WORLD WAR AND THE POST-WAR ERA

As often happens, war educated a reluctant medical profession. By 1939 the problems of the 'army which marches on its stomach' was with us again, but this time the army 'flew on its stomach' with a speed and to distances which set quite new demands on the commissariat. The era of 'food plenty for efficiency' had dawned and when after a few years the US Army was 'flying around the world' it demanded a very full stomach and all the gilt on the gingerbread. 'Our boys must have as good food as they had at home', said the American mothers. 'Subnutrition will undermine physical resistance and sap morale' said the Pentagon. The Army Food and Container Institute became one of the greatest subsidized factories in the world, and in turn began to stimulate important research programmes. The American Army fed like fighting cocks, even if the South African Army couldn't get all the biltong it desired. Although the British Army did not feed anything like as well as the United States Army the civilian rationing in Britain under the influence of Lord Woolton and the late

Sir Jack Drummond, building on the foundations of Boyd Orr and the Rowett Research Institute, achieved a triumph of food distribution, so that in spite of import difficulties the total population was better nourished and healthier at the end of the war than before it.

The first 7 or 8 years after the second world war can be regarded as the *protein* epoch in the development of nutritional science. The emphasis on vitamins in the 2 decades between the wars had obscured the importance of protein quality and amino-acid quantity. The foundations for protein physiology had been laid, particularly by Rose, Elvehjem and Holt in America, but the practical significance of protein deficiency had been missed because protein malnutrition was attributed to vitamin deficiency before the era of research in kwashiorkor.

Kwashiorkor and Protein Malnutrition

Among the many names under which this world-wide syndrome had previously masqueraded the only one which gave a definite suggestion of aetiology was the misleading term 'infantile pellagra'. Even this had been discarded for 'malignant malnutrition' in the African continent. At the first FAO/WHO Expert Committee on Nutrition at Geneva in 1949 there was nothing on the agenda about protein deficiency or kwashiorkor as a world problem of nutrition. I was able to get it there only by the subterfuge of asking leave of the Chairman to speak about 'infantile pellagra' under the agenda item 'Pellagra'. I apologized for the subterfuge but explained that I believed the syndrome to represent a world-wide problem of protein deficiency more important than any known avitaminosis. The debate which followed was the most interesting in the week's meetings and started a new direction of enquiry which has been extremely rewarding. World surveys of kwashiorkor and international conferences on protein malnutrition have followed each other in quick sequence and have focussed attention on requirements of nitrogen in general and of essential amino acids in particular. It has been shown that cure can be initiated in kwashiorkor by mixtures of amino acids with glucose and without vitamins. It is surprising that senior and responsible nutrition workers had found this possibility difficult to accept; I know that some of them were betting heavily on the failure of our amino-acid tests at Cape Town, Pretoria and Durban and were predicting the eventual discovery of a new vitamin to cure the syndrome. However, the central role of amino acids in protein malnutrition is now generally accepted. Minimum requirements for the essential amino acids have been worked out, but again it is at least possible that these have been overestimated because insufficient non-essential nitrogen was used in the tests.

Work in the field of protein malnutrition has incidentally thrown new light on liver disease and on the role of trace elements such as molybdenum as essential constituents of enzyme systems. Knowledge in these fascinating fields has only been scratched and much fascinating work lies ahead.

In the field of practical application, kwashiorkor, the most serious and widely prevalent disorder of human nutrition, can probably be largely abolished in a generation. It is becoming increasingly certain that suitable mixtures of vegetable proteins can replace animal protein to a large extent.

Intestinal Bacteria

The microbiological method for assessment of several vitamins is now established. The same methods are being used and hold great promise in the field of amino-acid antagonisms. These methods imply that bacteria have both minimum requirements and recommended allowances. The contribution of bacteria through intestinal synthesis to our requirement of vitamins began with the study of refection in rats when I was a student. It has developed today to the comprehensive studies of germ-free life by the Notre Dame School. The advent of broad-spectrum antibiotics has shown that we are indeed living in symbiosis with our calorie flora. They protect us from invasion by staphylococci and other pathogenic organisms as well as both contributing to our vitamin requirements and competing for our vitamin and nitrogen intake.

Essential Fatty Acids

Before the protein era had been properly launched the era of essential fatty acids was upon us. Reference has been made to the excellent health and nutrition of the people of Britain during the second world war. Few people noted the significance of this in terms of the American era of plenty. And so the US Army ration marched from 35 to 40 and then to 45% of calories from fat. Milk was drunk by the quart and ice-cream sold by the gallon; prime young baby beef became fatter and fatter on artificial pastures, steaks became bigger and fatter. Then came the bombshell. 'Our boys' who died in Korea were found to have significant coronary atheroma at the age of 22.

Although I am not always in agreement with Ancel Keys it cannot be denied that he has opened the eyes of the world to the dangers of over-consumption of fat. His international studies of the triangular relationship between coronary heart disease, blood cholesterol and dietary fat have created a turning point in thinking about the application of human diets to health promotion and disease prevention. For the first time a chronic process of aging has been shown to be preventable or modifiable. It is surprising that more attention was not paid earlier to the excellent health enjoyed by the people of England during the scarcities of the second world war, and to the decline in coronary heart disease mortality which occurred at the same time in the Scandinavian countries. The significance of these figures has only been appreciated as a result of the studies by Keys. Two principles have emerged, viz. (1) that the era of optimum dietary intakes is not necessarily leading to health, and (2) that in at least one respect recommended allowances may have been set dangerously high. I refer of course to fat intake. It has long been suspected that the recommended allowance of calcium and ascorbic acid of the United States Food and Nutrition Board is unnecessarily high; for a recommended allowance to be dangerously high is, however, another matter. A third principle emerges, namely that there may be important differences in quality within a class of nutrient which has been treated as a unit. The significance of qualitative differences between proteins has been apparent for some time and is slowly being interpreted in terms of amino-acid content. The significance of qualitative differences between fats has very recently become apparent, especially with relation to their effects on blood cholesterol. These differences will undoubtedly be interpreted in the near future

in terms of their number of double bonds, their chain length, their content of essential fatty acid etc.

Change in Medical Emphasis

During the last decade a remarkable change of attitude has come over the medical profession in regard to nutritional science. It suddenly appears that those of us who felt that nutrition was a field for scientific enquiry in its own right, and for its possible significance in relation to human health and disease, were not deceiving ourselves. Research into the nutritional aspects of disease has suddenly become exciting and intellectually rewarding.

Re-appraisal

And so the wheel has gone full circle. We have a Nutrition Council, a Nutrition Department, a Nutrition Research Institute, a Nutrition Research Advisory Committee, several Nutrition Research Units, and now a Nutrition Society. We are in the midst of a revolutionary re-appraisal of the relationship of diet to health and disease. Many new interests and possibilities are emerging. Old principles and standards are being challenged.

This challenge even extends to the American 'era of plenty'. Apart from the impracticability of applying American recommended allowances to the underprivileged world, even their desirability is being questioned. Rats and pigs appear to live longer if maximum growth rates are retarded by calorie restriction. A certain nutrition research worker riding around an English university town on an old bicycle in a state of self-imposed cachexia, is becoming the apostle of dietary restriction for longevity.

In the midst of this re-appraisal it is of course difficult to give advice on practical dietetics. A decade ago the medical profession left the dietetic advice to dietitians. Today every doctor feels obliged to give it himself. A decade ago the medical profession laughed indulgently at the whims of 'food faddists' both within and without the profession. Today the food faddists include the doctors who have, or who fear, coronary heart disease. Like Cassius they have 'a lean and hungry look'.

The dust and smoke, however, will clear and the dietitians will be left to their customary work. They will have new standards, but don't ask me at present what those standards will be. At least I suspect that many will be lower than present American recommended allowances. I am proud to say that our own dietary standards committee has taken a lead in this direction in the last revision of the South African Recommended Allowances, and I suspect that it will need to have another revision before very long.

The dietitians will have the responsibility for applying the new standards to the daily diets of our public institutions, our schools, our army and our industrial labour force. They will have the responsibility of educating our school children, our mothers, our housewives and even their husbands (and other people's husbands) in the new dietetic look. Even the French chefs may come to them for advice when their clients look anxious about their fat-calories. And I believe they will have an honourable place in partnership with the medical profession in therapeutic dietetics. The physicians will welcome their aid as soon as the novelty of unsaturated fats has worn itself into their thinking. I believe that the doctor should confine himself to general principles. He has neither the time nor the detailed knowledge to write menus. He will do much better to call in the dietitian for this purpose.