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THE TREATMENT OF KWASHIORKOR WITH MILK AND VEGETABLE PROTEINS

BY

R. F. A. DEAN, Ph.D., M.R.C.S., L.R.C.P.

(Medical Research Council Department of Experimental Medicine, Cambridge University;
now at Makerere College, Kampala)

The belief that kwashiorkor, as it occurs among children in the region of Kampala, is largely a protein-deficiency disease rests on evidence of several kinds. The diets in the weaning and post-weaning periods, when the disease usually appears, are lacking in protein (Trowell and Muwazi, 1945; Dean and Schwartz, 1952): the serum-chemistry of the children when they are admitted to hospital is consistent with a period of low protein intake, serum proteins and enzyme activity being reduced to low levels (Dean and Schwartz, 1952); and the activity of duodenal enzymes is also greatly lowered (Thompson and Trowell, 1952). The present paper offers further evidence from which the aetiology of the disease can be deduced. Two forms of treatment will be described which have been used successfully in Mulago Hospital, Kampala, within the last twelve months. In one of the treatments the chief item is milk protein; in the other there is a mixture of plant proteins, and no animal protein of any kind is included.

Protein, usually in large amounts and almost always of animal origin, has commonly been prescribed for the treatment of kwashiorkor, and cow's milk has been the source most often employed—for example, by Altmann (1948) and Walt, Wills, and Nightingale (1950). Human serum, liver, and hog's stomach have also been said to give good results; they have in common with milk the fact that they contain not only animal protein but also vitamin B₁₂.

Animal protein is expensive. It is seldom obtainable in adequate amounts in those parts of the world where kwashiorkor is common, and the provision of a cheap and effective substitute for the prevention and cure of the disease would be of great importance. Experience in the feeding of mildly undernourished German children with cereal-soya mixtures (Dean, 1949, 1951) suggested that it might be possible to treat kwashiorkor with diets containing protein exclusively of plant origin. A few children suffering from diseases that may have been similar to kwashiorkor had already been given such diets, with ambiguous results. Petrides (1948), working in Athens, fed three children on vegetarian diets the details of which were not specified, and found that the serum proteins did not improve, and the oedema did not subside, within 16 days. The addition of milk to the diets cured the children in the next 14 days. On the other hand, the children studied by Tiling (1947) in Hamburg

were said to benefit greatly from a commercial soya preparation. Unfortunately, the composition of the preparation was not divulged.

In descriptions of the treatment of kwashiorkor no attention has in the past been paid to the problem of finding the most suitable form for the carbohydrate in the diet. This is a surprising omission, since a large proportion of the total calories of any diet must be supplied as carbohydrate. The superficial resemblance between coeliac disease, which used to be treated extensively with bananas, and kwashiorkor does not seem to have suggested to anyone the use of bananas in the treatment of the latter disease.

The Children

The children who were treated at Mulago conformed to the clinical description of advanced kwashiorkor which has already been given (Trowell, Davies, and Dean, 1952; Dean and Schwartz, 1952). They had no discoverable complication.

For the first 18 to 24 hours after admission to hospital the children were given nothing but drinks of glucose-water. The special treatments were then started. Their original purpose was to provide large amounts of protein with no more than the unavoidable minimum of starch and fat.

The Milk-protein Diets

Ingredients.—The basis of these diets was dried skimmed cow's milk. A commercial concentrated milk-protein preparation was added to supply extra protein. Two kinds of skimmed milk were used; one was a roller-dried Kenya product, and the other a spray-dried powder of the finest quality, made in England. Both kinds contained 34% protein. The concentrated protein preparation contained 80% protein. The dried milk, reconstituted with water, and with or without the extra protein but with no other addition except sucrose from sugar cane or glucose of B.P. quality, was used in the earlier trials. Later some local foods were incorporated. Those which, for various reasons, were found most satisfactory were cooking bananas (*Musa balbisiana*; plantains), sweet bananas (*Musa sapientum*), and a finely ground maize flour.

Preparation.—The dried milk was mixed with water in a high-speed blender. Measured amounts of the reconstituted milk were put into glass bottles, which were then plugged with cotton-wool. The bottles were placed in a large saucepan filled with cold water, which was brought to the boil

and boiled for 20 minutes. The plantains were steamed in a double saucepan for one to one and a half hours. The sweet bananas were given uncooked. The milk was combined with the other ingredients by further use of the high-speed mixer. For children recently admitted to hospital who were believed to have the greatest difficulty in digestion, the final consistency was that of a thin gruel, smooth and free from lumps; for children who were on the way to recovery the gruel was thicker, and small lumps of banana were allowed to remain. A few children were given a porridge made by cooking the maize flour with dried skimmed milk and sugar in the proportions of 4:2:1. Enough water was used to ensure that the porridge was only moderately thick even when it cooled. The feeds of all kinds were warmed to about 37° C. before they were given to the children.

Results of Treatment with the Milk Diets

Dried skimmed milk was the cheapest available form of milk protein. It seemed an ideal treatment, provided that the children could be induced to take enough, because it had hardly any fat and contained a carbohydrate which, at least in its natural form, is usually regarded as innocuous.

Fig. 1 shows the progress of a child who was offered 170 g. of the Kenya skimmed milk, with 55 g. glucose. She was anorexic, and had to be given most of her feeds nasally for the first two days. She produced the loose stools that came to be recognized as characteristic of this diet; they were small in amount, looked mucoid, and contained flecks and small lumps of yellow material, here and there stained green. They smelt sour, and were acid in reaction. By the sixth day the general condition of the child was poor, and it was decided to stop the milk feeds entirely, although they were being taken fairly well, and to give nothing but glucose-water for one day. Since the day of admission 2 kg. weight had been lost, and, although the loss must have been largely due to the removal of oedema fluid, it was thought to be excessive. On the seventh day feeding with skimmed milk and glucose was resumed, but with the milk reduced to 110 g. The child's condition gradually became more satisfactory, and on the 16th day the amount

FIG. 1.—Case 1; a girl aged about 12 months, of the Muganda tribe (the tribe surrounding Kampala). History of swelling of body and diarrhoea for two weeks. On admission had brown hair of normal texture, oedema of feet, legs, hands, arms, and face. Fissures round the mouth. Treated with dried skimmed milk. The child made a good recovery, although the stools were nearly always loose. The days on which the stools were formed are indicated by the letter F.

FIG. 2.—Case 2; a girl aged about 12 months, of the Muganda tribe. History of three months' illness, with occasional diarrhoea and vomiting, and severe diarrhoea for two weeks. On admission had oedema of feet, legs, hands, arms, and face. Skin peeling in inguinal region, axillae, and popliteal fossae. Hair brown, scanty, and soft. Very miserable. Treated with the concentrated milk-protein preparation. The day after the preparation was first given the stools were formed (indicated by letter F). For three days the child took 105 g. protein daily. The increase in protein from the 24th day onwards was due to the addition of maize-milk porridge (not indicated in the diagram).

of milk was restored to 170 g., with 70 g. glucose. The weight gains were good, but the stools remained loose. It was thought possible that there might have been some defect in the Kenya skimmed milk, and on the 23rd day the spray-dried English milk was tried: it brought no improvement. At last, on the 27th day, the stools became formed and stayed so until the child was discharged.

Fig. 2 relates to another child who was offered at first 170 g. dried skimmed milk with 55 g. glucose. She not only had loose stools but failed to lose her oedema, and on the sixth day the diet was changed to 100 g. of the concentrated milk-protein preparation with 75 g. skimmed-milk powder. The next day the stools were formed, and they remained formed as long as this treatment was continued. On the 12th day the skimmed-milk/glucose diet was offered again; the stools deteriorated at once, but as the child's condition was good the diet was continued. After a few days the stools improved, the weight gains became satisfactory, and, although from the 24th day two helpings of maize porridge were added daily, there was no further upset and recovery was not interrupted.

The mixture of skimmed milk and concentrated milk protein was the most consistently successful of the various diets which had been tried at Mulago Hospital. It has been used in about 70 cases, often in the most difficult circumstances, and often when the treatment with the skimmed milk alone has proved unsatisfactory. It may be possible at a later date to present a statistical analysis of the results and a comparison with the other treatments. At the moment it can only be said that the introduction of the concentrated milk-protein diets has probably halved the death rate from severe kwashiorkor at Mulago (Trowell, 1952, personal communication). For reasons discussed elsewhere (Trowell, Davies, and Dean, p. 798) the rate is still of the order of 10%. In the present state of knowledge of the disease it is not possible to make an accurate comparison of the Mulago results with those obtained elsewhere.

The diets were usually accepted readily by the children, but if they were refused, as sometimes happened in the first few days, they could be given by stomach tube. It was unusual to have to continue tube-feeding for more than two days. The return of appetite was one of the most clear

signs of the beginning of recovery. The loss of oedema was also prompt, and the skin lesions, however extensive they might be, had always begun to heal by the end of a week. About the same time the demeanour of the child began to change; it lost its apathy and started to take an interest in its surroundings.

The alterations in serum chemistry have been described elsewhere (Dean, 1952a; Dean and Schwartz, 1952). In brief, they consisted in a rise in the total protein, brought about chiefly by an increase in albumin, rises in blood urea and cholesterol, in cholesteraesterase, non-specific esterase, amylase, and cholinesterase. The level reached by the urea was much higher than the normal for healthy European children, but there were no other signs or symptoms of uraemia. The levels of activity of the duodenal enzymes—lipase, amylase, and trypsin—also rose as treatment continued.

Carbohydrate Intolerance

At an early stage it became apparent that the stools provided one of the most important signs of recovery. This was in agreement with observations made previously at the hospital before the concentrated protein diets were introduced, and was presumed to indicate the better digestion that became possible as the enzyme systems were rebuilt. In some cases, however, recovery could occur without the stools being formed, and Fig. 1 illustrates this anomaly. Another interesting point gradually became clear. It was realized that, although the principle of high-protein therapy was sound, the improvement in the stools that was almost invariably brought about by this treatment might be due to another factor—namely, the incidental reduction in the amount of carbohydrate in the diet. The carbohydrate was made up of the lactose in the dried milk, and the sucrose and glucose added to increase the caloric value of the feeds. It was obviously necessary to try the effect of varying the amount of carbohydrate independently of the amounts of protein. The child whose record is shown in Fig. 3 received for the first eight days 170 g.

FIG. 3.—Case 3; a girl aged about 3 years, of the Mukiga tribe (inhabiting the south-west corner of Uganda, near the Congo border). History of two weeks' illness, with vomiting and gradually increasing swelling of feet and legs. On admission had oedema of feet, legs, and face; skin very little affected; hair brown, straight, and soft. Appetite good. Treated with (a) large amounts of dried skimmed milk and sugar, and (b) smaller amounts of the skimmed milk with the concentrated milk-protein preparation. Throughout treatment the child ate all she was offered. The intake of protein was consistently around 50 g. daily. Formed stools (indicated by the letter F) followed reduction in amount of sugar in diet.

FIG. 4.—Case 4; a girl aged about 18 months, of the Muganda tribe. History of one month's illness with diarrhoea and vomiting, and swelling of the legs for three days. On admission had oedema of feet and legs, skin fissures behind the ears and at corners of mouth, and black hair of normal texture. Very irritable. Treated with fairly small amounts of milk protein (less than 20 g. a day for 15 days). The delay in the formation of stools (indicated by letter F) was probably due to excessive amount of sugar given. From the 16th day, except on two days when milk drinks were given during an attack of malaria, the child ate large amounts of cooked banana. The weight of the solids of the banana (taken as 20%), and not the total weight, is shown.

skimmed milk, 70 g. glucose, and 60 g. sucrose; this supplied 58 g. protein and 215 g. carbohydrate. The stools were loose, and on the 10th day the diet was changed to 25 g. of the concentrated milk-protein preparation and 75 g. skimmed milk, which gave 45 g. protein and only 40 g. carbohydrate. The day after the alteration the child did not open her bowels at all, and after that the stools were formed. An increase in the amount of skimmed milk to 100 g. on the 15th day restored the total protein to 55 g. without altering the stools. On the 19th day 170 g. skimmed milk and 60 g. glucose were given, and immediately the stools became loose; they improved again when the high-protein diet was restarted, and finally remained satisfactory when, for the last time, a skimmed-milk/sucrose mixture was tried.

The response of this child, and scrutiny of the records of many other children, led to the conclusion that sugar was not well tolerated by the children suffering from kwashiorkor. There had been one or two children whose stools had not improved when they were given the concentrated milk-protein diet, and an explanation was now evident in the fact that the amount of sugar in the diet had been kept too high (see Fig. 4). The upper limit of tolerance naturally varied from child to child, but seemed usually to be in the region of 100 to 125 g. a day. Children recovering from pneumonia and other illnesses who did not have kwashiorkor were not upset by these amounts of sugar. The kind of sugar made no difference, sucrose and glucose producing the same bad results as the lactose of the skimmed milk.

The intolerance of sugar presented an awkward problem. It implied not only that there must be a limit to the amount of skimmed milk that could be given, but that some new way had to be found to augment the caloric intake. Fig. 3 shows a rise in weight, on the 19th to 22nd days of treatment, which was probably due to the increase in calories from 500 to about 925. The stools, however, then became

loose, although the calorie intake was still far below the level of 140–150 per kg. body weight, which would be near to the optimum for a child so severely underweight (Dean, 1952b).

It had been noticed that occasionally a child would pass a formed stool when it first came into hospital, but that afterwards the stools became loose. Figs. 2 and 3 show examples of this phenomenon. The formed stool nearly always contained recognizable lumps of the cooked banana, which was one of the principal items of the home diet, and this suggested the use of the banana as a vehicle for the protein and as a source of carbohydrate. Mixtures of cooked banana, dried milk, and sugar were made; they were taken readily by the children, who thrived on them. For example, Fig. 4 shows the excellent result obtained by feeding a child on 750 g. of the cooked banana, at first with 25 g. of the concentrated milk protein, and later with 75 and 125 g. skimmed milk. It was afterwards found that mashed sweet banana could be used in exactly the same way, and with as good effect, as the cooked banana. When either was included in the diet the stools became formed. They contained large amounts of undigested material, but the improvement in the children's general condition showed that, however much of the nutritive value of the food was being lost, an important part was being retained.

One hundred grammes of the cooked or the sweet bananas gave approximately 80 calories. All except the most sickly children could take at least 400 g. each day, and it therefore became possible to make large reductions in the amount of sugar without altering the total calorie value of the diets.

The Plant-protein Diets

If kwashiorkor can be cured by protein the curative agents must be either amino-acids or substances, such as vitamin B₁₂, which are found in association with some proteins. In theory, a mixture of amino-acids from plant sources, perhaps with a supplement of those vitamins normally found in milk, should be effective.

The work at Mulago has included an exploration, by experiments with rats and mice, of the possibilities of combining locally obtainable plant foodstuffs so that their proteins should supplement one another. The successful use of cooked banana suggested a starting-point and a basis, but it was soon found that the banana was not only a very poor source of total protein—100 g. contained less than 1.5 g. protein—but was almost certainly deficient in the essential amino-acid methionine (Dean, 1952a). It was therefore necessary to find some means of greatly increasing the protein in the banana diet and of repairing the deficiency of methionine. It is intended to describe the animal experiments in full at a later date. They have already shown, however, that banana, with soya and maize, and even banana with soya alone, will support good growth. The value of both diets was greatly enhanced by the addition of a mixture of vitamins—a finding which needs further investigation.

The Soya Preparations Used.—Two soya preparations have been used in the feeding of the children and in the animal experiments. One was a spray-dried soya "milk" made in England in the way described by Chang and Murray (1950), and containing 48% protein and 7% fat on a dry-weight basis. The other was made in the laboratory from beans grown in the vicinity of Kampala. The beans were soaked overnight in water, the husks were removed by rubbing, and the beans were ground. They were then packed into glass jars of the kind used for preserving fruit, leaving 4 to 5 cm. free at the top. The jars were filled with water, their patent tops were loosely fitted, and they were then placed in a large vessel containing water and cooked at 100° C. for three to four hours. After this process the jars of beans were autoclaved, either in a domestic pressure-cooker or in a hospital autoclave, for 20 minutes at 120° C. Steps were taken to ensure that the maximum temperature was reached quickly and that the temperature

was reduced rapidly at the end of the procedure. Sometimes the autoclave, with its valves open, was used for the steam-cooking also. The prolonged but carefully regulated heat treatment was necessary to render the beans easily digestible and to destroy the trypsin inhibitor without at the same time damaging the soya protein. The cooked beans contained 17% protein and 8.5% fat.

Results of Treatment with the Plant-protein Diets

The child whose chart appears as Fig. 5 was at first offered each day 500 g. cooked banana, 150 g. maize flour, 50 g. sucrose, and 25 g. of the dried soya milk. During cooking the maize flour took up about 400 g. water. The mixture was put through the high-speed blender, and in this process it was necessary to add more water, so that the final weight of the day's feed was about 1,250 g. The feed pro-

FIG. 5.—Case 5; a girl aged about 2 years, of the Muganda tribe. History of diarrhoea for one month. On admission had oedema of hands and feet, skin peeling in inguinal region, and brown, scanty, soft hair. Miserable. Appetite fair. Treated with a diet entirely of plant origin. For the first 12 days dried soya milk was used, and afterwards the soya beans. The weight of the solids of the banana, and not the total weight, is shown. After an early period of anorexia the appetite gradually improved and the child made a steady recovery. The stools were never loose.

vided approximately 31 g. protein (6.5 from the banana, 12 from the maize, and 12.5 from the soya) and 3 g. fat (nearly all from the soya). One gramme of a vitamin mixture was added. This was said by the makers to contain 2,000 U.S.P. units vitamin A, 400 U.S.P. units vitamin D, 0.6 mg. vitamin B₁ mononitrate, 0.9 mg. vitamin B₂, 6 mg. niacin, 1 mg. calcium pantothenate, 0.3 mg. pyridoxine hydrochloride, 0.6 mg. folic acid, 20 mg. vitamin C, and streptomycin fermentation extractives with an activity equivalent to that of 6 g. vitamin B₁₂. The diet was given for 12 days, during which time the child passed through a phase of anorexia, but lost a considerable amount of oedema and showed obvious clinical improvement. The stools were always well formed. On the 13th day the diet was changed to 500 g. of the cooked banana, 100 g. maize flour, 50 g. sucrose, and 300 g. of the cooked soya bean, and again 1 g. of the vitamin preparation was added. This diet provided 65.5 g. protein (6.5 from the banana, 8 from the maize, and 51 from the soya). The child continued to improve and gained weight steadily. The stools were not quite so well formed as when the soya milk diet was given, and were

bulky and pale, but they were never loose. The serum chemistry showed alterations similar to those obtained with the milk-protein diets.

At the time of writing about 20 children with kwashiorkor of various degrees of severity have been given soya. The cooked beans, which have the advantage of ease in preparation, have been used in most cases. There have been no untoward reactions, and the progress of the children has been much the same as could be expected on the best of the milk-protein diets. The concentrated milk-protein diet is still, however, regarded as the treatment of choice for those children who are most desperately ill.

Soya is not a very rich source of methionine, and it was at first thought necessary to introduce maize partly as a source of that amino-acid; it has been omitted, however, from the diets of several of the children without any obvious detriment. When it is omitted the total volume of the feeds is greatly reduced, an important advantage in the treatment of a very ill child.

It has been found particularly advantageous to make mixtures of sweet banana and soya. The children like them well, and the mixture of sugars formed during the ripening process in the banana seems to be remarkably bland.

A recent improvement in the soya diet has been to redress the unfavourable calcium:phosphorus ratio of soya by adding each day 8 g. calcium lactate, which gives 1 g. calcium. It seems desirable to add also sodium chloride, but this may be somewhat hazardous in the absence of any definite information about sodium retention. There are obviously many questions concerning mineral metabolism, and many others concerning the need for added vitamins, that await answer. The necessary investigations will occupy many months, but it can already be said that the results of using the banana-soya diets offer reasonable hope that advanced kwashiorkor can be successfully treated with diets entirely of plant materials.

The unfortunate results which attended the use of full-cream dried milk (containing 30% fat) in some early trials at Mulago raised fears that the children might be adversely affected by the fat in the soya diets. These fears have not been realized, and at the moment it seems likely that the fineness of division of the soya, rather than its fat content, may determine its successful use. Making a fine emulsion of the soya appears to enhance its digestibility.

It may be valuable to investigate the effects of adding small amounts of milk to the soya diets. It was found in Germany (Dean, 1952b), and has been noticed elsewhere, that the good effects of such additions seem at times to be out of proportion to the quantities of known food elements contained in the milk.

Discussion

It seems to be rational to use large amounts of protein in the treatment of kwashiorkor, but we are far from a complete understanding of why they are effective. There can be little doubt that the protein is urgently needed, and it is fortunate that the truly vital mechanisms for its breakdown and utilization survive to some degree intact. Balance studies in progress at Mulago (to be published later) have already indicated that in the early stages of treatment with milk or plant proteins there is almost certainly a great wastage of the proteins, but enough seems to be retained to start off the process of cure. The exact nature of the curative agent is unknown. So far, the work at Mulago suggests that this is not merely methionine—a confirmation of one of Waterlow's (1948) findings—or vitamin B₁₂, but investigations have been hampered by the difficulty of establishing basic diets adequate to supply all the other needs of the severely ill child and yet deficient in the amino-acid or the vitamin. The use of soya may be especially advantageous if some way can be found of utilizing the well-known fact that the extent of the biological availability of its methionine depends on the method of cooking employed.

Soya contains large quantities of lecithin, which on hydrolysis yields choline, one of the substances known to affect the mobilization of fat from the liver. Early reports of the use of choline in the treatment of kwashiorkor were not encouraging, but Meneghello, Niemeyer, and Espinosa (1950) decided that it accelerated improvement of the liver condition. If soya continues to be found of value it will be necessary to consider the possibility of its acting as an important source of choline.

It may well be that the cure of kwashiorkor is impossible unless a certain minimum of total dietary protein is exceeded; it has been noticed, however, that clinical improvement can sometimes be achieved by giving diets which contain smaller amounts of protein than have usually been employed and which do not bring about the characteristic alterations in serum chemistry. Thus one child who was fed on a diet of cooked banana, maize, and sugar, containing only 15 g. protein, showed by the 15th day no alteration in the level of total serum proteins, which remained below 3 g./100 ml. Nevertheless, by this time the skin had healed well and the oedema had been lost. The various lesions of kwashiorkor may not all respond equally to any one ingredient of a curative diet. To take an example suggested by the results of some of the animal experiments but remaining hypothetical so far as the children are concerned, methionine may affect the deposition of fat in the liver or its removal from that organ, and yet be unable to promote growth. The analysis of partial success in the treatment of the children should not be neglected, for by this it may be possible to distinguish between the various effects, and so to come to a better understanding of the processes that lead to recovery.

Only long-term experiment will decide whether or not the kind of success so far achieved in treatment represents a complete and permanent cure. Whatever diet has been used at Mulago, and however long it has been continued—one child was treated for nearly six months—the children have never displayed the great acceleration of growth which was seen in German children of comparable ages (Dean, 1952b). It is to be hoped that the fault lies in imperfections of treatment, which more experience will remedy. So far, no child who has received a complete course of treatment has had to be readmitted for another course; but the numbers are so small, and the public appreciation of the advantages of hospital treatment so uncertain, that the impression of sustained success may be illusory.

Brock and Autret (1952) bring evidence to suggest that the freedom from kwashiorkor which is enjoyed by many largely vegetarian communities may depend on nothing more profound than the suitable mixing of plant materials in the diet. If this is correct, it indicates a relatively easy method of prophylaxis and adds strength to the hope that the cure of kwashiorkor will not be allowed to remain the prerogative of animal protein.

Summary

An account is given of the successful treatment of kwashiorkor with diets containing large amounts of protein.

Concentrated milk protein gave the best results, but mixtures of plant proteins were also effective. The preparation of the diets, for which no special apparatus is needed, is described.

Cooking bananas (plantains) and sweet bananas were found to be excellent vehicles for the proteins, as well as providing a form of carbohydrate which is well tolerated.

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KWASHIORKOR

I. NUTRITIONAL BACKGROUND, HISTORY, DISTRIBUTION, AND INCIDENCE

BY

H. C. TROWELL, M.D., F.R.C.P.

Specialist Physician, Uganda Medical Department

AND

J. N. P. DAVIES, M.D.

Head of Department of Pathology, Makerere College Medical School

We appear to be entering a period in which, among highly cultured races, it is being taken more and more for granted that breast-feeding is largely unnecessary and that weaning involves few dangers and difficulties. However true this may be of the United States, Britain, and some European countries, it is far from true of the Tropics (Davies, 1952). There, for reasons which have been given by Banks (1951), the birth rate is almost everywhere high. Reproduction starts as early as possible, and births continue in rapid succession. Survival into adult life has, however, often to be considered exceptional, and, for this, faulty nutrition must be one of the main causes.

Nutritional Background

The child is always breast-fed in the first few months, and during this period, at least in the early pregnancies, the milk satisfies its needs. Between the sixth and the eighteenth month a crisis is often reached: a decision has to be made about weaning. It may be that another pregnancy has begun and custom demands that breast-feeding should stop, or the mother may have at last decided that her milk cannot be considered adequate.

The weaning involves not an orderly progress through a series of carefully adjusted foods with cow's milk always available as a basis or a reinforcement, but, all too often, a sudden change to the full adult diet, with no gradual introduction to solid foods. The adult's diet is itself usually faulty. It contains little protein and fat, and much carbohydrate and roughage. It seldom includes cow's milk, which is scarce and expensive. The commonest supplemental foods offered to the child are cereal gruels and chewed bananas, which do not rival cow's milk. Other foods, especially those rich in protein, are difficult to obtain. The preservation and storage of animal protein is almost always beyond the resources of a simple community, so that shortages are inevitable unless the supply is unusually constant. The available sources of protein are not so chosen that they supplement each other, and some degree of protein deficiency in the diet is almost invariable.

The weanling child may face other hazards. He may be separated from his mother and sent away to be brought up by other relatives. The best he can then hope to receive is the adult diet of his new family, eked out in a few instances by occasional breast-feeds from any woman who may at the time be lactating. Even if local custom permits his mother to continue breast-feeding when her new pregnancy is recognized, her milk may fail because poverty or taboo has so reduced her diet that she cannot meet all the simultaneous demands.

When to these difficulties are added the usual imperfections of cooking in tropical countries, and the frequent shortages of water, malnutrition becomes easy to understand. It strikes the child at a time when he is being exposed to increasing dangers of infestation and infection, and when his protein requirements are higher than they will be in any subsequent period.

The special nature of much of the malnutrition of children in the Tropics has been realized only in recent years. Malnutrition due to shortage of protein is a conception more recent than the discovery of the importance of vitamins. Its universality hindered recognition: the parents could regard its signs as those of a normal phase of development through which the child must pass. It escaped the European-trained doctor because it did not fit any known pattern of disease, and when at last it began to emerge as a clinical entity it was bedevilled by confusion with the more easily comprehended conditions of congenital syphilis, pellagra, and nutritional oedema. As the aetiology became clearer and the clinical and pathological features were defined, the importance and severity of kwashiorkor became only too apparent. It is one of the most widespread of all the disorders caused by faulty nutrition.

History

The disease was recognized by many African tribes, who gave it a variety of names, most of which indicated certain features, such as the oedema, or the changes in the colour of the hair and skin, or the displacement of the child from the breast by the new pregnancy. The term "kwashiorkor" was first introduced by Williams (1933). Its exact interpretation has been the subject of dispute. It was said to mean "red boy" in the Ga language of the Gold Coast, but recently MacPherson (1951) has suggested that it implies the "syndrome of the changeling"—a suggestion which will be of interest to students of European folklore. Although the disease was possibly mentioned by Hippocrates (Adams, 1939), modern knowledge dates from the studies of Normet (1926, 1927, 1937a, 1937b) in French Indio-China, Procter