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PROTEIN–CALORIE MALNUTRITION

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1. Introduction

Protein–calorie malnutrition (PCM) in its different forms and degrees, is still one of the most prevalent and widespread nutritional deficiencies particularly in infants and young children in the underdeveloped areas of the world (Scrimshaw and Béhar, 1961). Various degrees of PCM have also been observed in the low socioeconomic classes of highly developed nations (Taitz and Finberg, 1966), and in significant numbers of adults in developing areas. The high incidence of the severe, clinically recognized forms of PCM (kwashiorkor and marasmus) affecting from 1 to 10% of infants and preschool agers in developing regions, does not in itself indicate the true magnitude of the problem. This is because of the much higher proportion of children affected by the mild-to-moderate forms of PCM who can be identified only by retardation in growth and development. If retardation in growth is taken as an indicator of the magnitude of the problem, more than half of the preschool child population of underdeveloped areas of the world may be considered as affected by PCM (Béhar, 1968).

The severe, advanced forms (kwashiorkor and marasmus) are dramatic diseases which usually require hospitalization and are generally fatal if the children do not receive adequate treatment. The less dramatic but much more prevalent mild-to-moderate forms are not less significant as health problems because, as a component of the 'social deprivation syndrome', they contribute to the manifestations of this 'syndrome', which include high morbidity and mortality rates and inadequate physical and mental development.

2. Classification

The clinical syndromes described under the names of kwashiorkor, marasmus, marasmic kwashiorkor, protein deficiency, undernutrition, nutritional dwarfism, and many others, are all different types or degrees of PCM. The different manifestations of PCM result as a consequence of (a) the relative degree of calorie and protein deficiencies, (b) age of the subject, (c) magnitude and duration of the deficiencies, and (d) nature and severity of concurrent diseases.

2.1. Relative degree of calorie and protein deficiencies

When children are fed a well-balanced food such as milk, but in very insufficient amounts, or thin diluted cereal gruels, sweetened water, or other starvation-inducing diets, the net result is a progressive calorie deficiency. These children lose weight rapidly and, in order to survive, utilize their lipid reserves and their muscle and other nonvital tissues as calorie sources. The resulting extreme clinical picture is that of emaciation known as marasmus.

On the other hand, and usually after weaning, when children are forced to consume large amounts of starchy foods (cereal flours, roots, bananas, gruels made of refined starches), their calorie requirements may be satisfied but with 'empty calories'. Under these circumstances, a clinical picture of severe protein deficiency rapidly develops. This syndrome was known in Europe earlier in the century and was described by Czerny and Keller under the name of Mehlnärschaden (Czerny and Keller, 1925–8), and more recently by Jelliffe in Jamaica, as 'sugar baby' (Jelliffe *et al.*, 1954). These children develop edema and other manifestations of severe protein deficiency without significant growth retardation or loss of subcutaneous tissue. Since children fed such imbalanced diets naturally reduce their calorie intake because of anorexia, the 'sugar baby' syndrome develops only when they are forced to consume their food. This explains why the syndrome is only rarely observed. In most cases, in addition to the protein restriction, children subject to diets of this type will show a certain degree of caloric deficit and will develop a mixed syndrome with components of the two previously described. This is the syndrome usually described as kwashiorkor or, when the marasmic component is more obvious, as marasmic kwashiorkor.

2.2. Age

PCM of any type can occur at all ages. Kwashiorkor has been observed in ages ranging from young infants to adults, and the same is true for marasmus. However, marasmus is seen much more frequently in infants, mostly as a consequence of insufficient breast feeding or the use of overdiluted cow's milk, cereal water, or other diets with low energy density. Kwashiorkor is more commonly observed during the second and third years of life when weaning has occurred, and it is more likely for children to be fed starchy foods high in calories and very low in protein. Furthermore, the relatively greater energy and protein requirements, and smaller protein mass and calorie reserves of rapidly growing infants, make them more susceptible to the development of marasmus.

2.3. Magnitude and duration of the deficiencies

When nutritional deficiencies in children are not very severe but are of long duration, the growth rate will be primarily affected; however, the child will show little or no evidence of tissue loss. On the other hand, a severe and acute restriction of calories will result in emaciation (marasmus). The severe and acute restriction of proteins provokes edema as well as other signs and symptoms of kwashiorkor. Nevertheless, in either case, the child's size may not be significantly retarded for his age. In the case of acute and severe protein deficiency, even weight may not be drastically reduced after disappearance of edema. More frequently, severe protein deficiency develops in a child already markedly retarded in physical growth and very often with various degrees of emaciation as a consequence of chronic and moderate PCM. The resulting picture is that which has been described as marasmic kwashiorkor.

2.4. Nature and severity of concurrent diseases

Finally, to complicate the situation further, other nutritional deficiencies or diseases of a different nature may be superimposed on any of the different types and degrees of PCM, thus modifying the clinical characteristics.

These concurrent or complicating factors may also vary from region to region. For instance, vitamin A deficiencies or a certain type of anemia may be more frequently observed in children with PCM in one area than in another; or the frequency with which the syndromes are accompanied by diarrhea and dehydration may be different.

Summarizing, PCM may be manifested clinically in many different ways. The four variable, relative degrees of calorie and protein deficiencies, age of the subjects, magnitude, and duration of the deficiencies and nature and severity of concurrent diseases are, in our opinion, the main factors responsible for the clinical variation. Thus, the frequency of the different forms of PCM can vary from place to place or even in the same place as time goes on.

It has been observed, for instance, that in many parts of the world where kwashiorkor used to be the main manifestation of severe PCM, the prevalence of marasmus is becoming greater (McLaren, 1966). This change is the result of earlier weaning and improper artificial feeding of infants, often a consequence of urbanization or of a greater influence of occidental infant feeding practices in population groups who are unable to adopt them adequately because of cultural, environmental and socio-economic factors.

3. Effects of Calorie Deficiency and Protein Deficiency in the Individual

As is clear from the previous considerations, calorie and protein deficiencies induce various changes in the individual, depending on a variety of factors. The great majority of these changes are adaptative in nature and, except for the extreme deficiency states when failure of adaptation occurs, and acute, severe clinical disease supervenes, the protein and calorie deficient individual lives in an apparent healthy state except when a deeper look into his functional state is undertaken.

In the case of semi-starvation, which is primarily a process of caloric restriction, the following metabolic adaptations take place: the subject reduces his caloric expenditure by diminishing his activity and by slowing the basal metabolic processes below the decrease expected from active tissue loss. On the other hand, hormonal mechanisms are adjusted to facilitate lypolysis and lipid mobilization, and a certain degree of amino acid transport from muscle to viscera.

Protein deficiency induces adaptative mechanisms whose primary aim is protein sparing. Protein synthesis is decreased in the organism as a whole, although visceral protein synthesis is spared as compared to muscle and skin which serve as amino acid donors, thus increasing their relative catabolism. Total protein catabolism and urea synthesis are decreased and shifts in protein pools occur. As a consequence, the total protein mass is selectively decreased with sparing of specific organ proteins such as brain, kidney, liver, and heart.

Through these adaptative mechanisms the organism is able to endure mild and moderate calorie and protein deficiencies, with little impairment of its essential vital functions. Viewed in this light, calorie deficiency and protein deficiency are dynamic processes inducive of progressive adaptative changes. The more severely malnourished individual has necessarily reached a greater degree of adaptation which breaks down more easily by pathological or physiological loads, resulting in severe disease states which, if not treated adequately, can rapidly result in death.

It is important to keep the concept of adaptation in mind while interpreting functional and clinical manifestations of PCM, as well as in establishing rational bases for nutritional rehabilitation.

3.1. Characteristics

3.1.1. CHRONIC PROTEIN–CALORIE MALNUTRITION IN CHILDREN

The mild-to-moderate chronic forms of PCM are manifested primarily by a slow-down in the rate of growth. In the areas where the severe forms of PCM (kwashiorkor, marasmus) are prevalent, the large majority of children go through a period of chronic, moderate PCM. This usually starts by the fourth to the sixth month of age when, among other factors, breast feeding becomes insufficient as the only source of nutrient and the children do not receive proper supplementation or are inadequately fed when they are weaned. Their rate of growth slows down in relation to what is normal for their age, a situation which usually persists for months or years. In addition, they frequently show reduced physical activity and mental apathy, dry skin and hair, and are subject to frequent episodes of gastrointestinal disturbances (anorexia–diarrhea). Many of these children may either die from episodes of infectious diseases or they may develop an acute and severe form of malnutrition. After their second to fourth years of life, those who manage to survive usually resume a close to normal rate of growth. The other signs and symptoms may disappear, but they will remain small for their age. This condition has been described as 'nutritional dwarfism' (Jelliffe, 1959). Such children, small for their age but otherwise clinically normal and growing at a normal rate, are no longer malnourished but are showing the effects of a previous period of inadequate growth as a consequence of malnutrition. Changes similar to those in physical growth are observed in bone maturation (Garn *et al.*, 1964), and at present it is of great interest to clarify whether their mental development is equally affected. Although a good correlation has been found by some investigators between the physical growth and the performance of these children in some measures of psychomotor and intellectual development (Cravioto *et al.*, 1966), it has not yet been possible to demonstrate whether these last alterations are a direct result of malnutrition or of other components of the 'social deprivation syndrome'. Available information seems to indicate that malnutrition *per se* does interfere with the normal development of the central nervous system when it is severe and occurs during the first months of life (Monckeberg, 1969).

3.1.2. MARASMUS

Marasmus, which is primarily the result of severe calorie deficiency, is clinically characterized by extreme emaciation. The child, usually an infant, first stops growing and is later forced to utilize his own tissues to satisfy its basic energy requirements; initially, a large part of the adipose reserves and later a large proportion of muscle mass is utilized for energy purposes. The child with marasmus is therefore small for his age, and reduced practically to 'skin and bones' (Fig. 1). The head and the abdomen, sometimes distended, look large for the very thin arms and legs. The skin of the whole body lacks its normal turgidity and is wrinkled, thus giving the impression that it is too large for the reduced body. There is no clinical edema. If no other complications are present, the child is usually alert, cries frequently, and conserves a good appetite. Total serum proteins, albumin, and other biochemical indicators of severe protein deficiency, including the ratio of nonessential to essential free amino acids in plasma, are not significantly altered (Viteri *et al.*, 1964). The urinary excretion of hydroxyproline, a biochemical indicator of growth, is low, and in extreme cases the excretion of creatinine is also significantly lowered indicating a very reduced muscle mass (Whitehead, 1967). Similarly, although there is a marked atrophy of all the organs, no frank pathological alterations are observed. It seems, in general, that by utilizing their own tissues for surviving, these children do not develop the serious metabolic and pathological alterations observed in kwashiorkor.

3.1.3. KWASHIORKOR

Pitting edema, skin and hair lesions, gastrointestinal disturbances, and psychic changes are the most important clinical characteristics of kwashiorkor (Fig. 2). The

FIG. 1. Child 14 months old with marasmus; notice the extreme wasting and the typical facies.

edema is soft, painless, and partially localized by gravity. Although it is the sign on which, in our concept, the clinical diagnosis of kwashiorkor is based, the degree of edema varies from very mild and localized only in the feet and ankles, to cases in which it is so severe and generalized as to shut the patient's eyes from swelling of the eyelids, and to limit the person's movements. Most frequently it is present in the legs, lower abdomen, arms, and face, with little or no edema in the thorax. The degree of edema has no relationship with the severity of the protein deficiency.

The skin is almost always thin and dry and characteristic 'pellagroid' lesions are frequently observed (Fig. 3). There are areas of hyperpigmented and hyperkeratotic epidermis which peel off in large scales leaving tender, frequently exudative skin which can easily become infected. In infants, the lesions start and are more frequently observed in the perineal region; in older children, the extremities and later the face, neck, and lower trunk are the more affected areas. Hemorrhagic lesions of the skin, petechiae, and ecchymosis are observed in the very severe cases.

The hair becomes dry and brittle, straight when it has been curly, and can be pulled out easily. Frequently, it also changes color, black hair becoming reddish, yellow, or even white. These color changes may be seen over all the hair, or in stripes alternating with hair of normal color; this is known as 'flag sign' (Fig. 4). Neither the dermatosis nor the hair alterations are constant or indicative of the severity of the case.

Among the gastrointestinal disturbances, anorexia, diarrhea, and vomiting are

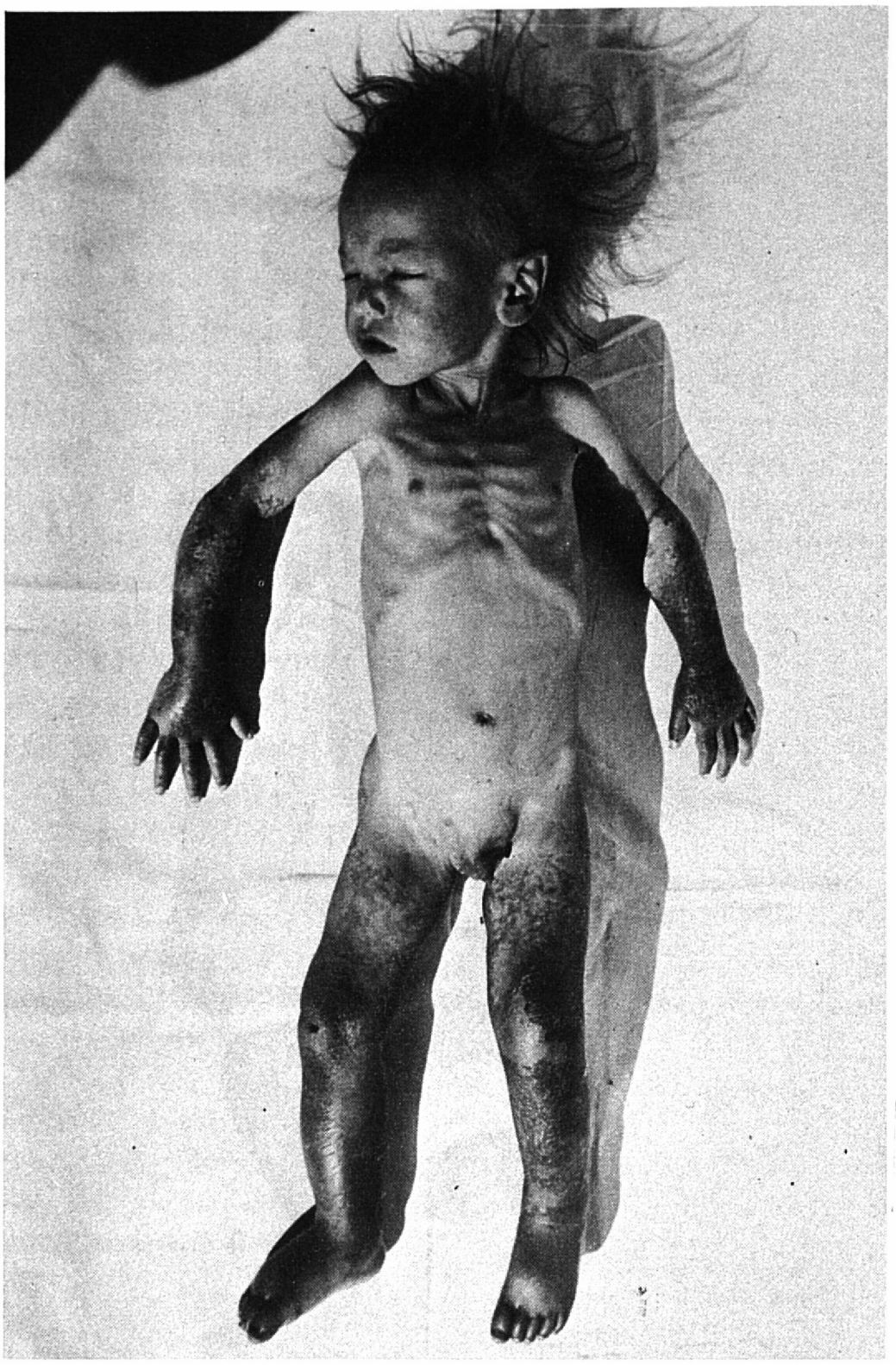

FIG. 2. Child 2 years old, with kwashiorkor, as observed in Central America. Notice the edema, the skin and hair lesions, the muscular wasting, and the apathy.

frequently observed. Lack of appetite during the first days of hospitalization may interfere with dietary therapy, but if the child is properly taken care of, this lasts for only a few days, to be replaced by a strong appetite. Diarrhea is frequently observed; in most cases it is associated with intestinal malabsorption and disappears with dietary treatment without any other specific measures. Even when clinical diarrhea is not present, these children often have large stool volume indicative of fat malabsorption, which persists during the first few weeks of treatment (Holemans and Lambrechts, 1955). Vomiting is frequent when the children are forced to eat large meals during the first days of hospitalization.

Psychic changes are very characteristic. Children are usually apathetic, indifferent to their environment, and even lethargic; at the same time they are irritable and cry very easily when disturbed.

As indicated previously, these children may have a variable degree of emaciation and growth retardation which reflect the condition of the child before he develops the acute severe manifestations of kwashiorkor. Different signs and symptoms due to other nutritional deficiencies or other complications such as dehydration may be superimposed on the above basic clinical syndrome. The clinical picture may also be complicated by various infectious diseases which may kill the child or interfere with recovery. These infections are not frequently detected due to reduced clinical manifestations such as fever and leukocytosis.

FIG. 3. Skin lesions characteristic of kwashiorkor.

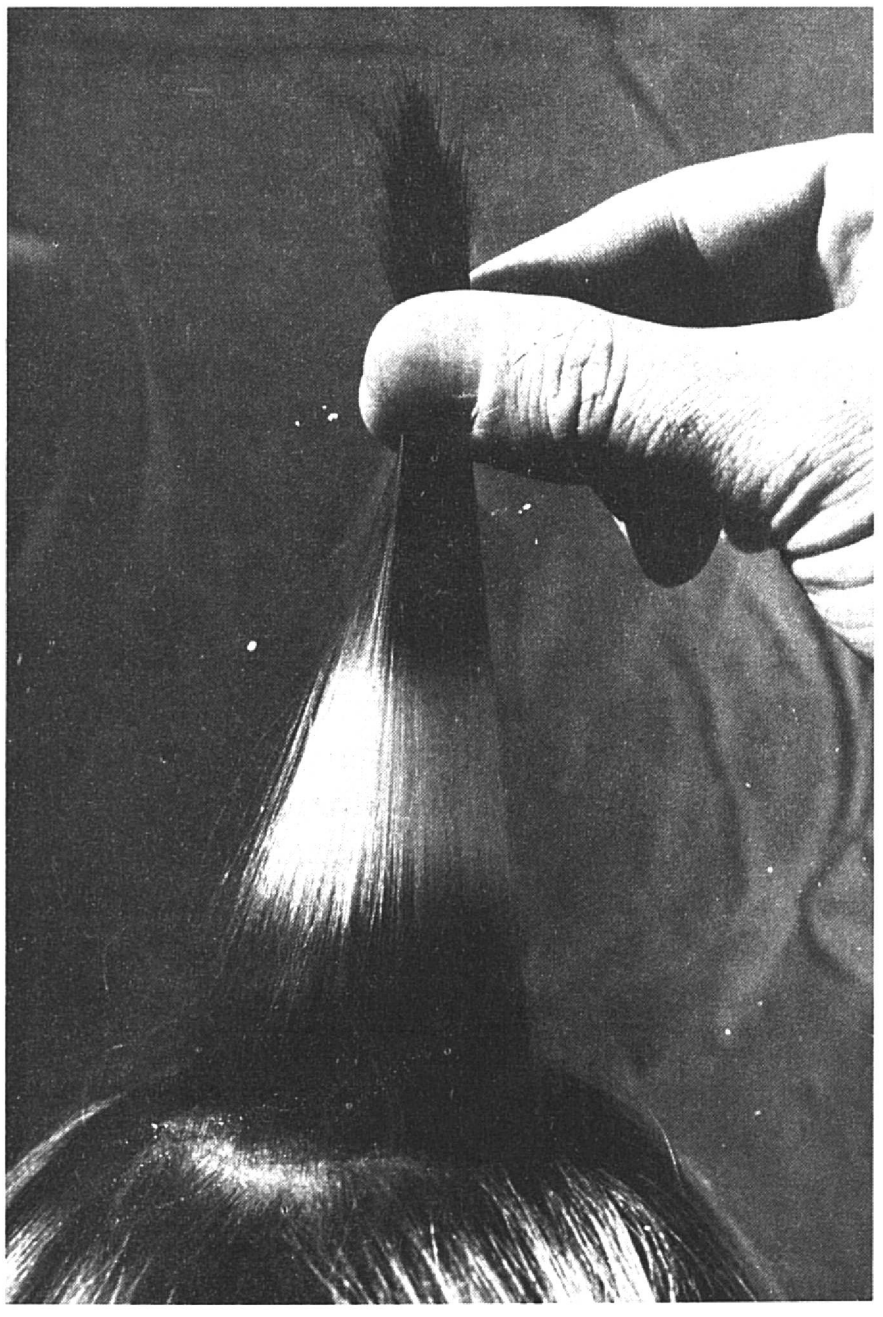

FIG. 4. Typical hair decoloration observed in kwashiorkor and described as the 'flag sign'.

Severe anemia may be another complication. This is common in children with severe hookworm infestation, in which case the anemia is microcytic hypochromic. Cases of megaloblastosis and macrocytic anemia associated with folic acid or vitamin B_{12} deficiency have also been reported (Adams, 1954). Megaloblastosis due to folic acid deficiency, or iron deficiency with microcytic anemia, develop after the initiation of cure if insufficient quantities of these elements are provided during treatment.

Even when no specific causes of anemia are present, children with kwashiorkor usually have low blood hemoglobin concentration and reduced packed red cell volume. This mild 'normocytic anemia' seems to be only an adaptation to a reduced metabolically active tissue mass and, therefore, a lower oxygen demand; this apparent anemia is progressively corrected as protein repletion is attained (Viteri *et al.*, 1968). Among the most characteristic biochemical alterations, the following can be mentioned: low total serum protein concentration due primarily to a marked reduction in the albumin fraction (Béhar *et al.*, 1956); the ratio of nonessential to essential free amino acids in plasma (Whitehead's index) is high (Whitehead, 1964); serum lipids, vitamin A and carotene are low (Béhar *et al.*, 1956); some serum enzymes, particularly amylase and alkaline phosphatase are markedly reduced (Dean and Schwartz, 1953), and there is a low urinary excretion of urea, creatinine, and OH-proline (Arroyave, 1969). The degree of body protein deficiency can be estimated by relating the creatinine excretion (Viteri and Alvarado, 1970) or total body potassium (Alleyne *et al.*, 1970) to that of a normal child of the same height.

The pathological lesions most frequently observed are: fatty infiltration of the liver, atrophy of the pancreatic acini, and other exocrine glands, as well as thinning of the gastrointestinal mucosa; the skin also shows atrophy of the epidermis and of the sebaceous glands and hair follicles (Béhar *et al.*, 1956). Bronchopneumonia is a frequent necropsy finding since this condition is a common precipitating cause of death in children with kwashiorkor (Tejada Valenzuela *et al.*, 1956).

4. Epidemiology

The immediately responsible etiologic factor of PCM in children is an inadequate diet, frequently acting in conjunction with the common infectious diseases of early childhood. However, in order to understand the real nature of the problem it is necessary to analyze it epidemiologically, considering the interaction of host, agent, and environmental factors. It is only from this type of analysis that the preventive measures most likely to be effective under each particular set of conditions, can be derived.

4.1. Environmental factors

The environment in which PCM in young children is most likely to occur as a public health problem is that of poverty and ignorance which characterizes large sectors of population in the underdeveloped areas of the world. In general, a low *per capita* income, low educational levels, and poor sanitary conditions are a common feature. The food supply in these communities, even when they are primarily agricultural, is quantitatively insufficient and qualitatively inadequate to satisfy the nutritional requirements of the population. This is the result of low productivity related to inefficient systems of land tenure and low economical and educational levels of the population, all of which hamper the application of modern methods of agriculture. This situation is further aggravated by the decreased working capacity of the agricultural workers due to malnutrition and frequent diseases. For these population groups, the scarcity of foods, particularly those of high nutritive value such as animal products (meat, eggs, milk), is also determined by their low purchasing power. For this reason, even when such foods are produced locally, they are consumed by the well-to-do sectors of the population or used for exportation.

The poor environmental sanitary conditions, low standards of personal hygiene, and insufficient medical services favor the high incidence of infectious diseases (diarrhea,

whooping cough, measles, etc.) which precipitate or aggravate the nutritional deficiencies in children already receiving an inadequate diet.

The social, cultural, and economic isolation in which many of these communities live, frequently with the family as the only economic unit, tends to perpetuate this situation.

The process of industrialization and urbanization, with the migration of peasants to the cities, creates the shanty towns where conditions are usually even worse than in the country. Not only are living facilities less adequate from the sanitary point of view, but since these people can no longer produce any food they must obtain it in the market, a situation which they are neither culturally nor economically prepared to face; consequently, they tend to invest their limited resources in a very inefficient manner. One significant change this process is producing in relation to PCM, which has already been mentioned and will be discussed later, is the shifting of the ailment to children of a younger age, and to a greater incidence of marasmus than of kwashiorkor.

The very rapid population growth in those areas where the problem already exists is aggravating the situation and making it much more difficult to correct by applying the necessary measures.

4.2. Agent factors

In the particular case of PCM, the agents are the sources of calories and proteins which act not by their presence but by their deficit.

Breast feeding is undoubtedly the most adequate and safest way of providing the calories and nutrients required by the infant. This is particularly true for populations living under the conditions described in the previous section which are neither economically nor culturally prepared for artificial feeding of their infants. Breast milk, if used as the only food, can satisfy the nutritional requirements of infants up to the age of 4–6 months. However, from then on, supplementary feeding becomes necessary. There are two problems related to breast feeding which are of interest in relation to the epidemiology of PCM. One is early weaning and the other is prolonged breast feeding with insufficient and/or inadequate supplementary feeding. Early weaning, that is to say, the complete interruption of breast feeding before the child reaches the age of 6 months, and in some communities even later, is dangerous when the families do not have the resources, the knowledge, or the facilities to feed their children artificially, adequately, and safely. Unfortunately, the industrialization and urbanization processes and the undiscerning cultural influence of the developed areas is resulting in a tendency to earlier weaning in many areas where the population is not yet ready for such practice. What is usually done in these cases is to feed the child with overdiluted cow's milk prepared and administered under very poor sanitary conditions. The frequency of diarrheal diseases at these early ages augments the consequent increase in the incidence of marasmus. At the same time, the incidence of kwashiorkor, which results from improper feeding after late weaning, is reduced. This switch from a greater frequency of the kwashiorkor to the marasmic type of malnutrition, and at earlier ages, is a phenomenon which is now being observed in different parts of the world, primarily as a consequence of the indicated factors (McLaren, 1966).

The other breast-feeding problem associated with the epidemiology of PCM, is one observed in primitive communities with many difficulties for feeding their children properly after weaning, and consists in prolonging breast feeding as much as possible. In such populations, weaning takes place during the second or third years of life. The problem resides in the very inadequate supplementary feeding, both from the quantitative and qualitative standpoints, when mother's milk no longer provides sufficient nutrients. This situation frequently continues after weaning, when the children are fed mainly cereal preparations or starchy roots or fruits. Under these circumstances, the children predominantly develop the mild-to-moderate forms of PCM manifested primarily by growth retardation after 4–6 months of life, and many develop kwashiorkor after complete weaning, more frequently during the second and third years.

The problem of feeding small children with diets based mainly on starchy foods (cereal preparations, cassava, plantain, etc.) that constitute the staples for these

populations and which are supplemented only with small amounts of legumes, vegetables, and fruits, and only occasionally with animal products, also merit discussion. There are two main limitations in these children's diets. One is that the protein content in relation to calorie concentration is very low, with the result that even when the calorie requirements are met, it is difficult if not impossible to satisfy the protein needs. In addition, these unbalanced diets frequently produce anorexia, thus reducing intake; consequently, not even the calorie requirements are met. The other problem is related to the biological value of the proteins of such diets which, in most instances, are deficient in one or more of the essential amino acids. This makes the possibility of satisfying the protein requirements still more difficult, particularly for infants and small children who have proportionally greater needs for both total protein and essential amino acids. The above explains why, in the same population, older children and adults who require a lower proportion of the calories provided by proteins and who can meet their total nitrogen and amino acid needs with proteins of lower biological value, are much less affected than infants and preschool children.

4.3. Host factors

Age is the most important factor related to the host in the epidemiology of PCM, and operates in the following ways. First, age is basic in determining nutritional requirements; as has already been indicated, the young child is more susceptible because of its proportionally higher requirements in calories, total protein, and essential amino acids.

The young child who has not yet developed immunity to the infectious agents of the environment is also more frequently and seriously affected by diarrheal and respiratory diseases and by the common infections of early childhood. That the role of these infectious processes, superimposed on nutritional deficiencies, is responsible for PCM, is well known (Scrimshaw *et al.*, 1968).

Finally, cultural factors which influence feeding practices in relation to the age of the child, are also important. Of the foods available and consumed by the family, small children are frequently offered only those which are considered adequate and safe for them. In most cultures, the criteria for selection are based on erroneous beliefs, and usually work against the interests of the recently weaned child. The high frequency of diarrhea and other diseases worsens the situation, because during these episodes the child's usually poor diet is restricted still more and for long periods, with serious nutritional consequences.

5. Treatment

Hospitalization is recommended for treatment of severe cases of PCM (kwashiorkor and marasmus), especially when they are aggravated by other complications (dehydration, infections), as is frequently the case. A general pediatric ward presents, however, some problems for these children, particularly because they become exposed to acquiring infectious diseases which interfere with their recovery. Ideally, therefore, a special ward or an isolated unit should be considered for them. In any case, hospitalization is required for at least the initiation of cure; ambulatory treatment as outpatients is usually ineffective because such children are often anorexic and the mothers have problems in feeding them properly, even if they are provided with food. Furthermore, if not properly treated, the children may easily die as a consequence of the complications.

The following stages are recommended in the treatment of severe cases of PCM (Alvarado *et al.*, 1970).

5.1. Emergency treatment

At this stage, the principal purpose is to save the life of the child. Children are not usually taken to the hospital until they are very ill and the large majority of deaths occur within the first 48 h after admission. Therefore, before the fundamental dietary treatment is instituted, it is very important to correct the conditions which can interfere

with recovery and could cause death. A very careful and complete clinical examination should be performed to indicate the need for one or more of the following measures.

5.1.1. CORRECTION OF DEHYDRATION AND ELECTROLYTE IMBALANCES

Both marasmic and kwashiorkor patients are frequently dehydrated as a consequence of diarrhea and vomiting. Even the kwashiorkor cases with severe edema may show signs of dehydration and may die in spite of the large retention of water in the extravascular space as edema.

Dehydration in the malnourished child is usually accompanied by hypo-osmolarity, a tendency to acidosis and to deficiencies of potassium and sometimes magnesium, with retention of sodium. The glomerular filtration rate is also frequently reduced. All these factors should be taken into consideration in the institution of fluid therapy directed towards their correction. Fluid administration is recommended intravenously only when clinical signs of dehydration are present. Fluids and electrolytes should be administered orally when the child does not seem clinically severely dehydrated. One-half to one-fourth normal electrolyte osmolarity solutions containing glucose are recommended to initiate diuresis. Sodium should not be given in amounts greater than 1 mEq/kg/day unless additional losses through diarrhea and/or vomiting have to be compensated. The recommended doses of potassium are 4–6 mEq/kg/day, but in the case of continuous additional losses, these can be raised to 7–11 mEq/kg/day. Potassium should be administered only after an adequate diuresis is ensured. Sometimes, when neurological manifestations of magnesium deficiency are present, the intramuscular administration of magnesium sulfate solution is indicated.

5.1.2. TREATMENT OF INFECTION

Special efforts should be made to discover any possible infection that may be complicating the case so as to institute prompt treatment with the appropriate anti-infectious drugs.

Respiratory infections are common. Diarrhea is also a frequent complication, but most cases can be corrected by dietary and fluid therapy without specific treatment. If amebiasis is demonstrated, specific treatment is recommended, but emetine should be avoided. For the treatment of other intestinal parasites, it is preferable to wait until the general condition of the child has improved.

Hepatic and cardiac insufficiency should be kept in mind as other possible complications during the first days of hospitalization.

5.2. Etiologic dietary treatment

While the measures indicated in previous paragraphs are instituted, the child should be started on a therapeutic diet. We recommend feeding the child progressively, starting with the administration of cow's milk preparations in amounts to provide approximately 1 g of protein/kg/day, and about 70–80 cal/kg/day during the first few days, rapidly increasing the amount in accordance with the tolerance of the child. The rationale for a cautious initial feeding schedule is that the child is maximally adapted to very low protein and calorie intakes and a large load of these nutrients may cause a discompensation with complications which may precipitate death. Other foods, such as bananas, eggs, vegetables, meat, cereals, etc., may be added progressively so as to offer a varied and complete diet according to the age of the child and to provide up to 4–5 g of protein and 120–150 cal/kg/day. In marasmic children it may be necessary to increase the calorie intake up to 200 cal/kg/day, to attain an adequate recovery rate.

During the first days, when the child is frequently anorexic and has a tendency to vomit if forced to eat, small but frequent feeding administered with great care by specially trained personnel is recommended. If this is not possible and the anorexia is severe, it may be necessary to resort to feeding by gastric tube until the appetite is recovered.

Although fats are not absorbed well during the acute stage, they can be given in the diet in normal amounts. An intolerance to lactose may be present and manifested by

diarrhea, but this can be corrected by reducing the amount of milk. The use of calcium caseinate or other lactose-free rich-protein foods to achieve the required protein intake, and of sucrose and vegetable oils as calorie sources in the formula, may be necessary in these cases.

When a varied and adequate diet is provided, it should satisfy the needs of all essential nutrients and no vitamin or mineral supplements are usually necessary, with the following exceptions. Vitamin A, preferably by intramuscular administration of a water-miscible preparation, and in adequate doses, is indicated as of the day of admission because of defects in absorption and transport of fatty esters of vitamin A in severe PCM. This measure assumes particular importance in areas where the deficiency of this vitamin is prevalent, and especially if the child shows ocular lesions suggestive of vitamin A deficiency. This is necessary to prevent keratomalacia which frequently complicates the severe cases of PCM.

Folic acid should be given at the initiation of therapy until a varied folate-rich-diet is instituted, particularly since milk is a poor source of folate. Iron supplementation is also needed, starting a few days later. These erythropoietic substances are necessary to satisfy the greatly increased demand of rapid hematopoiesis; otherwise, megaloblastosis may rapidly develop and hypochromic-microcytic anemia almost certainly will appear as the child recovers.

Once the clinical manifestations of severe nutritional deficiencies (edema, skin lesions, apathy and anorexia) have disappeared and the child is tolerating a varied, good quality diet and gaining weight rapidly—a situation which is usually reached in two to three weeks and sometimes even within a shorter period in the less severe cases—he may be discharged from the hospital but should be kept on a high protein, high calorie diet. Approximately 3 g of protein and about 120 cal/kg/day are recommended until complete nutritional recovery is attained, which generally requires two to three months. Convalescent homes or other appropriate services are extremely useful for this purpose.

5.3. Adaption to the home diet

Before the child is discharged from the hospital or from a convalescent home to which he may have been transferred after initiation of cure, we have found it very useful to adapt him to a diet which not only satisfies nutritional requirements, but that, as far as possible, is based on the type of foods the child will likely receive later on at home, considering the family's food availability. It is precisely this type of diet, which is adequate for the child and based on the cultural and economic characteristics of the family, in which the parents should be instructed, before the child is discharged, preferably by practical demonstrations. The purpose is to prevent a relapse, often observed in hospitals where children are cared for without any concern as to what will happen to them after discharge.

Treatment of mild and moderate cases of PCM which do not require hospitalization, is based on the institution of an adequate diet. To attain this, it is often necessary to provide the families with dietary supplements, particularly high protein foods such as skim milk or vegetable mixtures of high nutritive value. Another possibility is to give the children one or more complete meals in specially organized centers. In any event, whatever method is used for supplementing the home diet of the children to correct deficiencies, special emphasis should be placed on the utilization of food supplementation as a valuable tool for practical education of the mothers (Bengoa, 1967). In these cases the purpose should be not only to rehabilitate the particular malnourished child, but as far as circumstances permit, to help correct the inadequate dietary practices of the family.

6. Prevention

As indicated in the epidemiological analysis, the basic responsible factors for PCM in children, when existing as a public health problem, are associated with social,

economic, and cultural limitations of societies in underdeveloped countries. A complete and permanent solution of the problem can therefore be expected only by correcting these limitations, and particularly by increasing general food availability, economic capacity, educational levels, sanitary conditions, and the availability of adequate public health services. Unfortunately, for most of the areas where the problem exists, this is a very long term proposition. Furthermore, poor health and malnutrition are among the factors contributing to maintaining these characteristics of the underdeveloped population groups. It is therefore imperative to attempt to break this vicious circle and to apply measures of more immediate action. Among these, we can distinguish between those specifically related to the problem and those only indirectly related, but equally important.

6.1. Specific measures

These include actions oriented towards the general population such as food enrichment programs or the introduction of new foods, as well as those towards the individual subjects, which would include supplementary feeding programs and person-to-person nutritional educational activities. The first, when successfully applied, have the advantage of a greater coverage although their effects are much less subject to direct evaluation. These include: supplementation of staple foods with proteins and/or with the limiting amino acids (Bressani and Elías, 1968); introduction of new and more nutritional varieties of the staple food, for instance, opaque-2 corn (Mertz *et al.*, 1965), and introduction of new foods of high nutritive value adaptable to the financial and cultural conditions of the populations, such as vegetable mixtures especially designed as weaning foods (Bressani and Béhar, 1964). Many programs of this type are being implemented in different parts of the world. Nevertheless, as indicated previously, their direct impact will be difficult to evaluate because of the impossibility of separating their effects from those derived from other changes in the general living conditions which are taking place at the same time. However, in our opinion, wherever possible these measures should be applied if their beneficial effects have been experimentally proved under controlled conditions.

Supplementary feeding programs to vulnerable groups, particularly pregnant and lactating women and weaning and post-weaning children, have been very extensively used. These consist primarily in the direct distribution, at little or no cost to the consumer, of protective foods such as skim milk or others selected with the intention of correcting the prevalent dietary deficiencies. When properly designed and applied, especially in regard to the selection and control of the beneficiaries as well as of the supplements, and when the distribution of food is accompanied by intensive nutritional educational activities, they can be extremely effective. Nevertheless, their coverage is usually very limited, and frequently the bulk of the population most in need cannot be reached by these programs.

Supplementary feeding programs for school children can be useful also if the food supplements are properly selected and used primarily as educational tools to improve the dietary habits of the children, preparing them as future adults. The need of foods as nutritional supplements is generally of less importance at this age than in late infancy and the preschool years.

Nutrition education should be regarded as a regular activity in all the health programs, as a fundamental component of supplementary feeding and should be incorporated also into the systems of formal education in primary and secondary schools. This also applies to agricultural extension, home economics, or community development programs and should always be emphasized since the educational factor is of importance in the selection, conservation, preparation, intra-familiar distribution and consumption of foods.

When possible, special advantage should be taken of mass media communication methods for nutrition education of the general population. Due to the importance of this aspect and considering that the ultimate goal of educational activities should be to improve dietary practices and not to transmit knowledge, it is fundamentally important

to test the efficiency, in regard to the capacity of modifying food habits, of the methods and of the content now being used and, if necessary, to develop new procedures. Advantage should be taken of recent advances in the sciences of communication and of the new techniques available for this purpose. The maintenance of breast feeding for at least the first 6 months of life, the proper supplementation of breast feeding and adequate weaning and post-weaning feeding practices, as well as the adequate feeding of children during disease processes, all within the local possibilities and cultural characteristics of the particular population, should be the basic messages to be transmitted.

6.2. Nonspecific measures

Because of the important epidemiological role played by infectious diseases in the development of PCM, all measures directed towards the control of these diseases are of great value in prevention.

The implementation of environmental sanitation programs such as introduction of safe water, adequate excreta and waste disposal, fly control, personal hygiene, and food quality control would be of great impact in reducing the incidence of diarrheal diseases and intestinal parasitism, and consequently, the prevalence of PCM, particularly the severe forms which they frequently precipitate. Vaccination programs against the preventable diseases of childhood, especially whooping cough and measles, could also be of great value. In areas where endemic diseases such as malaria and schistosomiasis are a problem, their control would also bring about an improvement of the overall health and financial situation of the population, thus favoring better nutrition. Doubtless, the elimination of these further burdens on small children would also help in the prevention of PCM.

Social and health programs for the working population aimed at improving food production and economic development of the area are also important. Finally, family planning programs, besides reducing the number of children to be fed and cared for in each family, also prolong birth intervals. This would be of great value because it would allow the mother to feed each child and to take proper care of them for longer periods, ideally over the second or third years of life before she is forced to concentrate her efforts and attention on another newborn. It is worthwhile to bear in mind that neglect of a child because of the birth of a younger sibling, is the interpretation that has been given to the term kwashiorkor.

As the previous considerations reveal, the prevention of PCM is a complicated matter which requires organized, systematic efforts from the public health agencies and from all sectors of society. This is imperative for humanitarian reasons. In addition, it should be emphasized that malnutrition is responsible not only for the high morbidity and mortality rates of children, but also is an important contributory factor to inadequate mental and psychological development, and to low productivity of adults. Because of these deleterious effects on society, malnutrition should be considered among the important factors which are limiting the efforts for social and economic development.

7. References

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