Observations

ON THE

INFLUENCE OF FOODS RICH IN ACCESSORY FACTORS IN STIMULATING DEVELOPMENT IN BACKWARD CHILDREN.*

BY

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THE children described in this paper were in one ward of a large foundling hospital in Vienna, where we were permitted to work by the courtesy of the director, Dr. Gustav Riether. They varied in age from 1 to 3 years, and in growth, body weight, activity, and general development each was considerably below the normal standard for age and had been so for many months previously. The backward condition was in no way associated with existing illness, and the observations made on the group were of interest by demonstrating each child's approach to normal standard when dietetic changes were introduced.

In this institution there is an effective system of recording the body weight, diet, development, and medical history of every child, and it was therefore possible to trace the progress made since admission in the first weeks of life. The hospital is established in spacious modern buildings, and has a small staff of trained nurses, who supervise the wards. The care of children is undertaken by mothers, admitted with their infants from the obstetric clinics, who remain three to four months, in order to nurse their own babies and to assist in the care of those without mothers. As frequently happens in large institutions, the life of mothers and children is rather confined, and, owing to shortage of fuel, overcrowding could not be avoided in the reduced number of pavilions it was possible to heat.

Careful study of the past diets of the special group of children showed that after the three first months of life the calorie value of their dietary was usually adequate when breast milk had been supplemented by artificial food; but the types of food used suggested that defective growth might be due to qualitative deficiencies in the diet, from shortage of fats and of fresh elements. The frequent occurrence of infantile scurvy (Barlow's disease) in the institution and the prevalence of rickets pointed in the same direction.

The diets of the children consisted of diluted cow's milk, to which was added sugar, cereals, or proprietary infants' foods. The amount of vitamins in the food was therefore reduced in proportion to the amount of this dilution, and the same was true of the fat content. The antiscorbutic value of the milk food was further reduced, owing to the time that elapsed before it was consumed. It was reckoned that all milk was three to four days old when it was consumed in the wards. There is also little doubt that during the warm months the milk was heated at least once before delivery. All the food for some hundreds of infants was prepared in a central milk kitchen by standardized methods, which were studied in detail. The kitchen arrangements were admirable and there was no overcooking, but the irregularity of the milk delivery and the necessity for preparing large quantities at once, caused delay in the whole process of preparation. The food was prepared according to standard receipts under the control of one sister who had been in charge of the milk kitchen for over ten years.

By the courtesy of the director and with the co-operation of the physician in charge of the ward, dietetic treatment of a group of children was undertaken from December, 1919, to June, 1920. The main diet was still supplied from the central kitchen, but addition was made of (1) antiscorbutic material to supply this accessory factor, and (2) fats rich in the fat-soluble accessory factor.

Condition of the Children before Treatment.

In this communication nine children are specially selected for study; their ages ranged from 12 to 31

months. A short survey of their condition when first seen is set out in the accompanying table (p. 1065). All were under the normal weight for their age and in most cases the deficiency amounted to 25 or 30 per cent. The delay in development was more striking than the low body weight.

Four of the nine children could not sit up without support. Case 7 at 21 months lay inert, and if a limb were raised it fell back helplessly. Case 9, 31 months old, could not hold its head up for more than a few minutes and took no notice of its surroundings or of being handled. The absence of any spontaneous activity or movement among the children was a very striking feature. They showed little signs of awakened intelligence, they had no desire to play, and the older children made no attempts at speech.

With two exceptions, weight at birth was normal; Case 1 was a premature baby weighing 2,000 grams, and Case 8 was a twin and weighed only 1,600 grams. All had had some amount of breast feeding in the early months of life, and one child had had a complete diet of breast milk until 7 months old; most of the children, however, had made little progress at first, in spite of the breast feeding. It should be noted that the dates of their birth—1918 or early 1919—coincided with a period of great food deprivation in Vienna, and it is therefore probable that the mothers were imperfectly nourished during both pregnancy and lactation. In hospital, however, there was no serious shortage of calories in the diets after the breast feeding was supplemented or replaced by artificial food. The supplementary artificial food began from birth in 4 cases, and before 4½ months in 5 cases.

From the data available the calorie value and the proportion of milk fat in the diets were calculated from birth up to the time of the first examination of each child. The energy quotient or ratio of the calories consumed daily to the body weight expressed in kilograms was also calculated. This value was always maintained at the accepted standard and averaged well over 100; in some cases it reached 150, 180 and even 200 for varying periods of time. The amount of milk fat was low in comparison with that taken by an infant fed on whole milk of good quality, whether human or cow's. The antiscorbutic value of the diet was low for the reasons given above.

Previous Illness.

The past history of the children showed furunculosis and otitis in many cases, but the outstanding fact was the occurrence of definite scurvy once or oftener in every instance except Case 1. Case 8 had suffered from two attacks, at 6½ and 13 months respectively, and Case 9 (31 months old) from three attacks, at 16, 20, and 24 months respectively. These two children were the most backward of the series considering their age. The symptoms of scurvy had consisted in swelling and tenderness of the limbs, especially the thighs, and in haematuria; mouth symptoms were rare.

In the treatment of scurvy in this institution some whole raw milk was given in the diet for a period varying from one or two weeks to some months, the time depending on the rate at which the symptoms subsided, and the amount upon the supply of raw milk available. In some cases raw lemon juice was also given, but no satisfactory method existed for its administration. Recovery was slow and often partial; in Case 8 symptoms persisted over a period of several months. Study of the weight charts of these children convinced us that failure to increase in weight was often associated with deficiency of antiscorbutic material in the diet. In many cases increase in weight had taken place when extra antiscorbutic was added to the diet, or when raw milk was substituted temporarily for the heated milk food.

Presence of Rickets.

Some symptoms of rickets were present in all children, and in five cases the disease was severe and definite deformity was present. A survey of the whole institution, made in March-June, 1920, showed that some degree of

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† Lusk (*Science of Nutrition*, third edition, 1917, p. 404) concludes that 80 calories per kilo of body weight would suffice during the first year of life; Heubner (*Berl. klin. Woch.*, 1901, vol. xxxviii, p. 449) allows 100 for the first three months of life, 90 from three to six months, and 80 afterwards; Holt (*Amer. Journ. Dis. Child.*, 1921, xxi) places the standard at 120 for the first few months and at 100 until the end of the first year.

rickets was common at 5 and 6 months of age, and that the disease was practically universal at 9 months—that is, at a period considerably earlier than that at which it is ordinarily supposed to be manifest. In arriving at a conclusion as to the existence of rickets attention was directed to the following points:

1. Condition of anterior fontanelle; presence of cranio-tabes; development of parietal and frontal bossing.
2. Enlargement of costochondral junctions; development and contour of chest.
3. Enlargement of epiphyseal ends of long bones at wrists and ankles; bowing of the tibiae.

Description of Treatment.

Treatment consisted in enriching the diet of these children with (1) the antiscorbutic vitamin and (2) the fat-soluble vitamin in form of animal fat. The diets remained otherwise unchanged except that in some cases food was withdrawn to balance the additional calories given in the form of fat. The energy quotient was in no case increased. The general management of the children remained the same.

The antiscorbutic material was given in the form of raw swede turnip juice, 10 to 20 grams daily; experimental work on guinea-pigs had indicated that the raw juice of this vegetable possesses antiscorbutic properties comparable with those of fresh oranges or lemons. The clean cut surface of the raw vegetable was grated on an ordinary kitchen grater and the pulp squeezed in muslin by hand. It was given alone or with the food and was well tolerated in all cases. It was occasionally replaced by orange juice or lemon juice (neutralized with solid calcium carbonate and filtered), but during the winter 1919-1920 these fruits were too scarce and too expensive in Vienna for general use.

The fat-soluble vitamin was given in the form of cod-liver oil and butter. The initial dose was 10 grams of butter daily; in February, 1920, the daily dose of butter was increased to 20 grams for five of the nine children, and to these, in the month of April, 10 grams of cod-liver oil daily were given in addition. Cases 1 and 3 received cod-liver oil only, and Case 2 received an extra ration of 400 c.cm. full milk daily—that is, about 12 grams of milk fat.

The result of these additions to the diet was in every case satisfactory. The children began to put on weight at a more rapid rate than formerly, and the normal curve was gradually approached during the six months of treatment (see Table). The improvement is specially evident in Cases 8 and 9, where departures from the normal weight for the age, as great as 4 and 4.6 kg., were reduced to 1.2 and 2.4 kg. respectively.

But more striking than the increase in weight was the improvement of the children in general activities. Taking the four children, aged respectively 12, 21, 22, and 31 months, who were unable to sit alone, Case 7 could do so after six weeks, and Cases 1, 8, and 9 after two and a half to three months of treatment. Of seven children who showed no spontaneous movement of the legs when first examined, four (Cases 1, 4, 5, 8) stood within three months, and after six months all the children were beginning to walk. Another sign of satisfactory development was the rapid closing of the fontanelle, which in every case was open before treatment was begun.

Data collected from the past histories and during the period when the children were under observation were set out in charts showing the calorie value and fat content of the diets, together with the weight curves, plotted against the normal. That given by Pfaundler (1916) has been adopted as giving a fair average for normal growth. The past histories proved to be of great interest, especially

as showing the influence of scurvy or of a prescorbutic condition upon increase in weight. It would take up too much space to give the detailed description of all the nine children, but four cases (4, 7, 8, and 9) have been selected as being specially instructive. Case 4A, that of a little girl nearly two years old, not, however, treated in the present series, has been added as a striking instance of growth induced by adding antiscorbutic to a deficient diet.

CASE 4. (Chart 1.)

At birth, August 22nd, 1918, this child was of normal weight (3.1 kg.), was breast-fed for six weeks, and then received diluted cow's milk, with additions of sugar, till six months old. Full milk and cereal were then given for a month. At seven months this was largely replaced by malt-soup (*Malzsuppe*), a preparation with calorie value equal to full milk, consisting of 33 per cent. milk, 4 per cent. flour, and 10 per cent. malt extract. The child thrived poorly from the start, and the weight curve deviated more and more from the normal until about the tenth month.

The total calories (approximate) and daily ration of milk fat, together with the energy quotient, are plotted on the chart underneath the weight curve. There is no evidence of lack of calories in the diet throughout this period; the energy quotient varied from 120 to 150 during the first six months, and later (seven to ten months) it varied from 150 to 180; but, nevertheless, the child only put on 400 grams weight in this period. It is evident, therefore, that the high calorie intake had little effect in stimulating growth. The inhibiting factor appears to have been the deficiency of antiscorbutic material in the diet. Severe symptoms of scurvy were noticed at eight and a half months (April 29th, 1919), after a period of about seven weeks

in which malt-soup figured largely in the diet. As demonstrated by Hess and Fish (1914), malt-soup is especially poor in antiscorbutic properties, for the milk is diluted 1 in 3 with water, and the food is boiled twice during the preparation. It is therefore possible that the malt-soup diet precipitated the onset of acute symptoms. The diet was changed at once to include a plentiful supply (1,000 to 600 c.cm.) of raw full milk, and growth began to take place slowly for the first month while the symptoms of scurvy remained, but later more rapidly. At 12 months the child weighed 5.5 kg., and at 16 months 8.1 kg. During this period there was no increase of calories or of fat, and the energy quotient progressively declined in value.

The prescorbutic period was marked by an attack of furunculosis. The scurvy attack was of a particularly severe character, the right thigh showed skin haemorrhages and was swollen and tender and the leg was maintained in a flexed position; blood cells were present in the urine. The acute symptoms yielded but slowly to treatment with raw milk, and after forty-one days (June 13th, 1919) haematuria still persisted. A persistent deformity (shortening of the right leg) was left; x-ray photographs taken in October, 1919, five months after the acute attack, when the child was 14 months old, showed structural deformity of the right femur, with 1 cm. shortening of the thigh as compared with the left; the left femur was also affected, but to a less degree. At this period a definite "rosary" and slightly bent tibiae are recorded as evidence of rickets.

Two months later, in December, 1919, the child was first seen by us. She was then 16 months old, and was receiving the mixed diet usual in the institution, consisting of milk, cocoa, puddings made with milk and cereals, finely sieved cooked vegetables, and a little bread. It was calculated that this diet had a calorie value approximately equal to 1,000 calories daily and contained 30 grams daily of milk fat. The weight curve was approaching the normal, but she was still 20 per cent. under weight for her age; her fontanelle was open; she had four teeth, but made no attempt to speak. The deformity of the right leg was still very obvious; she could sit up unsupported, but could not stand. She received a regular antiscorbutic in the form of 20 grams daily of raw swede juice or orange juice. The milk fat in her diet was gradually increased from about 30 grams daily to 35 to 40 grams, and later some cod-liver oil was given.

She made good progress during the succeeding five months, put on over 2 kg. in weight, the teeth erupted rapidly, the fontanelle was closed, there was marked increase in general intelligence and activity, and she learnt to walk.

This was the only child of the series who appeared to be unable to tolerate cod-liver oil, which caused loss of appetite accompanied by loss of weight, and consequently had to be discontinued.

CHART 1.—Case 4, Barbara J., born August 22nd, 1918. B., Breast milk. R.M., Raw cow's milk. F.J., Raw fruit juice. E.Q., Energy quotient of diet.

Summary.

1. Marked failure to grow during the first nine months of life, associated with lack of antiscorbutic material in the diet, culminating in an attack of acute scurvy.
2. Growth in weight restored on inclusion of raw milk in the diet.
3. Permanent deformity of scorbutic origin in long bone of the skeleton.
4. An attack of furunculosis during the prescorbutic period, possibly due to a diminished resistance to infection.
5. Good progress from 16 to 21 months, when extra milk fat and antiscorbutic were added to the diet.

The next case offers interesting confirmation of the conclusions drawn from Case 4 as to the effect upon growth of a deficiency of antiscorbutic material in the diet. This child left the home shortly after our first visit in December, 1919; she received no treatment from us, and her case is not therefore included in the accompanying table.

CASE 4A. (Chart 2.)

At birth, on March 18th, 1918, the child was of average weight (3 kg.); she received some breast milk for six weeks, after which the diet consisted of diluted cow's milk and sugar, and from the third to the fifth month included a considerable amount of malt-soup. From the fifth to the twelfth month some full milk and cereal were given.

During this period growth in weight was very poor, and at 12 months the child's weight was about half that normal for the age. There had been no lack of calories in the diet (see Chart 2), but until the age of six months the proportion of milk fat was very low and never exceeded 20 grams daily. Later this improved, and from 10 to 12 months 30 grams of milk fat was taken daily. There was a deficiency of antiscorbutic material in the diet, especially when the malt-soup was given.

The prescorbutic period was again punctuated by various infections, furunculosis was noted at 6 months of age, again at 8 months and at 9 months; the child also had an attack of bronchitis at 10½ months.

At 12 months some degree of rickets was noted. At 13 months (April, 1919) acute symptoms of scurvy were recognized; blood was found in the urine, the gums were swollen, and the lower half of the right thigh was swollen and tender. The thorax was flat and the epiphyses thickened but not sensitive. Fruit juice was given and raw milk; this treatment was continued for three months. Growth in weight took place immediately this antiscorbutic treatment was begun; the weight, which was 5.2 kg. at 13 months, improved to 6.8 kg. at 16 months, and 9.2 kg. at 21 months, and was fast approaching the normal (11.4 kg.). Mixed diet containing vegetables was introduced at 17 months.

When seen by us at this time she was making progress although backward: she could stand but did not walk, she had eleven teeth but made no attempt to speak.

CASE 7. (Chart 3.)

F. B. weighed 2.8 kg. at birth on April 4th, 1918. He also showed poor development during the first year of life. Breast-feeding was partial (300-350 c.cm. daily) until 5 months old, but at this age the weight had increased only to 3.6 kg. The artificial food given had consisted of malt-soup, and after breast-feeding was discontinued malt-soup formed the entire diet for a short period. At 6½ months the weight was only 3.8 kg.; breast milk was again introduced, supplemented by increasing amounts of full cow's milk. At 8½ months

the weight was 4.4 kg., and the diet was changed to diluted cow's milk and cereal food.

At 11 months (weight = 4.9 kg.) definite symptoms of scurvy, swollen gums, and red blood cells in the urine were noted. Lemon juice and some raw milk were given; the scurvy symptoms improved slowly and were still apparent after four months' treatment, but the effect of antiscorbutic material in the diet was evident in the weight curve, which showed a slow but distinct improvement. The raw milk was continued for ten months (December, 1919), when the child was 21 months old and weighed 8 kg.

At this period we first saw the child in the backward condition summarized in the accompanying table. He could hold up his head but could not sit unsupported. His muscles were flaccid, the body fell limply forward, and if arm or leg were handled it would fall back helplessly when released. There was no spontaneous movement, muscular power was that shown by a normal baby of three months; the child resented handling and cried continuously. Dentition was not markedly backward and there were ten teeth. The contour of the head was very rachitic, the fontanelle was widely open and the epiphyses at wrists and ankles were enlarged. After this examination the antiscorbutic treatment of 150 c.cm. raw milk daily was increased (December, 1919)

by the addition of 20 c.cm. of potent material in the form of raw turnip juice or orange juice. Butter was given (10-20 grams daily) and later 10 grams of cod-liver oil in addition, so that the daily fat ration reached 35-45 grams.

The following is a short summary of his progress:

Three weeks (January 16th, 1920). Weight 8,460 grams. Some improvement in muscular power, can sit up with some support but still feeble, and makes no attempt to use legs. More contented and sleeps better.

Six weeks (February 4th, 1920). Weight 8,710 grams. More active, can sit alone, and kneel in cot holding on to the bars with hands.

Ten weeks (March 5th, 1920). Weight 9,390 grams. Stood for first time; rickets less prominent in head contour, tibiae slightly bowed, chest contour good.

Twenty weeks (May 14th, 1920). Weight, 10,630 grams. Fine looking child, active, skin healthy, subcutaneous tissues firm, stands easily. Rickets much less apparent, head contour much improved, no parietal, and only slight frontal, bossing, tibiae straight, chest contour normal; wrist epiphyses show slight swellings.

Twenty-four weeks (June 16th). Weight 10,900 grams. Beginning to walk.

The improvement in weight is well seen in Chart 3, the 30 per cent. deficiency from the normal at 21 months is reduced to a 10 per cent. deficiency after five to six months' treatment.

Summary.

1. This case shows a period of poor growth in weight, culminating in an attack of acute scurvy; improvement in growth in weight on adding antiscorbutic material to the diet.

2. Marked improvement in growth and also general progress and activity on adding a larger ration of antiscorbutic, and at the same time increasing the milk-fat.

CASE 8. (Chart 4.)

Ida P., born February 11th, 1918, was one of twins, and was much under normal weight at birth (1.6 kg.); her twin brother weighed 1.4 kg. She received a complete diet of breast milk for nearly three months; then followed a transitional period of mixed feeding for a few weeks, after which the diet was completely artificial, and consisted of diluted milk and cereal

CHART 2.—Case 4A. Marie B., born March 18th, 1918. B., Breast milk. R.M., Raw milk. F.J., Fruit juice. M.D., Mixed diet.

CHART 3.—Case 7. Friedrich B., born April 4th, 1918. B., Breast milk. R.M., Raw milk. F.J., Raw fruit juice. B. i., Butter 10 grams daily; B. ii., butter 20 grams daily. C.P. i., 10 grams cod-liver oil containing phosphorus; C.P. ii., cod-liver oil and phosphorus discontinued.

food. This was continued for four months; at six months of age (September, 1918) definite symptoms of scurvy were observed. The child screamed on being handled, swellings were noticed on the left thigh and left shoulder, the epiphysis of the left humerus was swollen and painful, the muscles over the right tibia were swollen and oedematous, and skin haemorrhages were noted on chest, neck, and back. Raw full milk was introduced into the diet (800 to 600 c.cm.), fruit juice was given and an infusion of pine tree needles. The symptoms cleared up slowly, and after two months raw milk was discontinued and scurvy was considered to be cured. At this time (ten months) a moderate degree of rickets was noted.

During the first four months of life on breast milk the child made fair progress and the weight curve ran fairly parallel to the normal. There was marked flattening during the period preceding the scurvy attack and while the symptoms lasted. The weight, which had reached 4 kg. at 6½ months, remained stationary until 9 months, when the child weighed only 4.2 kg. After the definite symptoms of scurvy had disappeared some progress in weight was noted; although some full milk was retained in the dietary it was not given raw, and both fat content and antiscorbutic value were low. The short period of growth from 9 to 12 months was succeeded by another stationary period from 12 months (5.3 kg.) to 15 months (5.5 kg.). During this period there is a continuous record of coughs, feverish colds, etc., and in March, 1919, at 13 months of age, a second attack of acute scurvy took place, shown by a swollen, painful femur and presence of blood in the urine. Treatment with whole raw milk was again instituted, and at 14 months vegetables were also introduced into the diet. Growth in weight began slowly and proceeded evenly until December, 1919, when we first saw the child. Raw milk in decreasing amount had been continued with slight intermission till this date.

The child was then 22 months old, and weighed 7.6 kg., about 35 per cent. below normal. She was limp and passive, and her muscles were flaccid; she could neither sit nor stand, nor was there any attempt at spontaneous movement. She showed a moderate degree of rickets; she had four teeth, the fontanelle was still open, and distinct frontal bossing was present. The chest was rachitic in contour, with projecting sternum, palpable rosary, and a lateral sulcus at the rib junctions. The legs were straight, but there was a slight thickening of the lower ends of both tibiae. The wrists were not enlarged.

During the six months she was under observation she received daily 20 grams antiscorbutic material (raw lemon juice, swede-turnip juice, or orange juice) and 10 grams of butter. In February, 1920, the butter was increased to 20 grams, and in April 10 grams of cod-liver oil were given in addition. There was a dramatic improvement and the weight curve began to make a steep ascent towards the normal; five and a half months of treatment (up to June, 1920) reduced the deficiency in weight from 35 per cent. to 11 per cent. The child was then 27½ months old and weighed 11.1 kg. (normal for that age 12.5 kg.).

The rapid increase in weight during this period was accompanied by marked general progress, which is summarized in the Table. After five to six months of the

enriched diet the little girl (at 28 months) was a transformed creature; she was active, merry, and plump, could stand and walk round her cot, and was trying to talk. She had twelve teeth, her fontanelle had closed, and there was a very striking remission in the signs of rickets noted on our first examination. No rosary and no swellings of the epiphyses were to be felt, and the chest contour had much improved. (See photograph.)

An unexpected control for this case was discovered in a twin brother, who had also been in the institution since birth but remained in another ward in the same building. The salient points of his past history were obtained, and his weight curve is plotted alongside that of his sister's (see dotted weight curve in Chart 4), and runs fairly parallel with it.

The brother suffered also from a severe attack of scurvy during the first year of life, and in his case the symptoms appear to have been present persistently from the ninth to the eighteenth month. During this period the body weight increased only from 4.2 to 5.3 kg., so that at 18 months of age the child was about half the normal weight. After this period various additions to diet were given in form of cod-liver oil and meat juice, but no regular antiscorbutic was given, and the weight curve remained very unsatisfactory until May, 1920, when he received for the first time raw lemon juice. This change coincided with a sharp upward turn in his weight curve.

It was at the end of this period that we first saw the child, who was feeble, anaemic, and unable to sit up without support. His arms and legs were thin and ill developed, his condition was lethargic, and he showed no signs of intelligence. The contour of the head was rachitic, the fontanelle was closed, but there was marked frontal and parietal bossing, the chest was compressed laterally, there was

a definite rosary, and the abdomen was prominent. His condition exactly reflected that of his twin sister six months previously before her diet was enriched. The contrast between the two children is well shown in the accompanying photograph.

We are inclined to attribute the improvement in the twin sister principally to the effect of a regular and potent antiscorbutic in the diet, for the proportion of fat, though increased also, was not so greatly altered, and the child also had been taking

a small amount of cod-liver oil daily before she came under our notice.

CASE 9. (Chart 5.)

V. J., aged 2½ years old when first seen, was the oldest of the series and at the same time the most backward. She was about 35 per cent. under weight for her age, did not even hold up her head, and made no attempt at spontaneous movement. She weighed 2.8 kg. at birth (May 12th, 1917), and after one

Ida P. (left) and Johann P. (right), June 22nd, 1920, at 28 months of age.

CHART 4.—Case 8, Ida P., born February 11th, 1918. B., Breast milk. R.M., Raw milk. V., Vegetable food. F.J., Raw fruit juice. C.P. I, Cod-liver oil with phosphorus 5 grams daily; C.P. II, cod-liver oil and phosphorus discontinued; C. III, cod-liver oil 5 grams daily; C. IV, cod-liver oil 10 grams daily. B. I, Butter 10 grams daily; B. II, butter 20 grams daily. Dotted curve = Johann P., her twin brother. C. J., Cod-liver oil given. L. J., Raw lemon juice. Curves representing daily calorie and fat intake and antiscorbutic in diet refer to Ida P.

Case No.	Sex.	Date of Birth, and Wt. in Kg.	Date of Examination.	Age (Mths.)	Duration of Treatment (Mths.)	Body Weight (Kg.).	Normal for Age (Kg.).	Difference (Kg.).	Description.	Treatment (daily).	History of Scurvy and Other Illnesses.
1. J. U.	M.	7.12.18 (2.0)	22.11.19 5.3.20 14.5.20	12 14 17	0 2½ 5	6.2 8.2 9.6	9.4 10.1 10.8	3.2 1.9 1.2	Cannot sit. No attempt to use legs; rickets severe in head and chest; enlarged epiphyses; no teeth. Moves actively; stands in cot; shows signs of intelligence; rachitic deformities less obvious; no teeth. Can stand unsupported; tries to talk; rickets arrested, though deformities persist; tissues firm; muscular power good.	10 g. antiscorbutic. 10 g. cod-liver oil. Cod-liver oil 20 g. from April 15.	
2. J. R.	M.	5.1.19 (3.5)	22.12.19 13.4.20 16.6.20	12 15 13	0 3 5	5.9 8.9 9.2	9.4 10.3 10.8	3.5 1.4 1.4	Can sit; tries to use legs; fontanelle open (2 cm.); slight signs only of rickets; good muscular power; two teeth. Stands well with support; colour good; traces only of rickets; 6 teeth; fontanelle still open. Fontanelle closed and firm; slight enlargements of epiphyses the only sign of rickets; can stand alone and walk round cot; 5 teeth.	20 g. antiscorbutic from Jan. 10, 1920. 400 c.c. extra milk from Feb. 10, 1920.	Scurvy at ½ months.
3. R. H.	M.	10.10.18 (2.9)	22.12.19 13.4.20 15.6.20	14 18 20	0 4 6	8.2 9.9 10.8	9.9 10.8 11.7	1.7 0.9 0.9	Can sit but makes no attempt to stand; well grown; good muscular power but activity poor; general development as for child of 9 months; rachitic stigmata in rib junctions and epiphyses; fontanelle open; 4 teeth. Active; stands in cot; no progress in rachitic stigmata; fontanelle closed; 12 teeth. Can just walk; tone of all tissues good; enlarged epiphyses the only sign of rickets; development normal for age.	20 g. antiscorbutic. 10 g. cod-liver oil from Feb. 18, 1920.	Scurvy at 8½ months.
4. B. J.	F.	22.8.18 (3.1)	10.12.19 5.2.20 14.5.20	16 17½ 21	0 1½ 5	8.1 9.1 9.9	10.3 10.7 11.4	2.2 1.6 1.5	Can sit but cannot stand; tone of tissues good; spontaneous movements not vigorous; fontanelle open; 4 teeth; rickets slight. Backward child, still suffering from effects of a severe attack of scurvy; right femur shows 1 cm. shortening. Stands and can walk with assistance; no progress in rickets; fontanelle almost closed; marked general improvement. Condition good; child vigorous and intelligent; activity normal for age; dentition proceeding rapidly; rickets stationary.	20 g. antiscorbutic. 20 g. butter. 10 g. cod-liver oil in addition from April 15 to May 12, 1920.	Scurvy. 8½ to 10 months; furunculosis 6 to 7 months.
5. W. W.	M.	5.8.18 (2.9)	5.12.19 5.2.20 8.5.20	16 18 21	0 2 5	8.7 9.7 11.6	10.3 10.8 11.45	1.6 1.1 —	Can sit but cannot stand; well grown; makes no spontaneous movements; pallid; no obvious sign of rickets; 5 teeth. Stands with support and moves vigorously about cot; paller less marked; epiphyses slightly enlarged. Can stand alone; condition good; fontanelle closed; 7 teeth; intelligence and activity normal for age (three weeks later could walk alone).	20 g. antiscorbutic. Butter, 10 g. from Jan. 1, 1920; 20 g. from Feb. 17, 1920. 10 g. cod-liver oil in addition from April 15, 1920.	Scurvy at 10½ months; furunculosis.
6. A. D.	M.	30.6.18 (4.1)	22.12.19 3.2.20 13.4.20	18 19 21½	0 1½ 4	9.5 10.7 12.0	10.8 11.1 11.6	1.3 0.4 —	Child sits and can stand up in cot; muscular power good, but activity poor and mental condition lethargic; marked rachitic deformities of head, chest, and legs; tibiae bowed; shortening and disproportion of limb; fontanelle almost closed; 8 teeth. Child had fracture of the radius at 12 months following severe attack of scurvy. Stands well; tries to walk and to talk; seems normally intelligent. Rickets arrested. Excellent condition of all tissues; activity normal for age; intelligent; deformities less marked; 10 teeth.	20 g. antiscorbutic. Butter 10 g.; 20 g. from Feb. 17, 1920.	Scurvy. 7 to 11 months; furunculosis.
7. F. B.	M.	4.4.18 (2.8)	23.12.19 4.2.20 5.3.20 16.6.20	21 22 23 26	0 1½ 2½ 6	8.1 8.7 9.4 10.9	11.4 11.7 11.9 12.3	3.3 3.0 2.5 1.4	Very backward; no attempt at spontaneous movement; all tissues flaccid and muscular power very defective; limbs fall limply after being raised; child lies inert and resents handling; head rachitic and epiphyses much enlarged; fontanelle widely open; 10 teeth. Can sit alone and can kneel in cot; muscular power improved but legs still feeble; 15 teeth; is making rapid progress. Can stand; rickets arrested and deformities less marked; fontanelle closed; colour improved. Child beginning to walk; all tissues in good condition; rachitic stigmata retreating; head contour improved; remarkable improvement in activity and intelligence; marked disproportion of limbs to length of body.	20 g. antiscorbutic. Butter 10 g.; 20 g. from Feb. 20, 1920. 10 g. cod-liver oil from April 15, 1920.	Scurvy. 11 to 15 months.
8. I. P.	F.	11.2.18 (1.6)	23.12.19 4.2.20 3.3.20 13.4.20 1.6.20	22 24 25 27 27½	0 1½ 2½ 4 5½	7.6 8.3 8.9 9.8 11.1	11.6 12.1 12.2 12.3 12.5	4.0 3.8 3.3 2.5 1.4	Very backward; cannot sit even with support; tissues soft and muscles very flaccid; child passive and makes no attempt at spontaneous movements; rickets shown in moderate degree in head, chest, and lower ends of tibiae; fontanelle open; 4 teeth. Child shows no intelligent interest in surroundings; marked pallor. Tries to sit; is more active; rickets stationary; still pallid; fontanelle open; 4 teeth. Can sit alone, but makes no attempt to stand; muscular power still feeble; fontanelle closed; 6 teeth. Child appears more intelligent and tries to talk. Marked improvement in activity; tries to crawl; 12 teeth; is intelligent and contented. Child can stand and walk round cot; is active, merry, and plump; general condition excellent; slight signs of rachitic stigmata remaining in head and chest.	As for Case 7.	Two attacks of scurvy, at 8 months and 13 months.
9. V. J.	F.	1.5.17 (2.8)	5.12.19 3.3.20 14.5.20 1.6.20	31 34 36 37	0 3 5 5½	8.1 9.5 10.8 10.9	12.7 13.0 13.1 13.3	4.6 3.7 2.3 2.4	Very backward; cannot sit alone and can hold head up only for a short time; body limp and helpless; child pallid and feeble; lies passively in cot and takes no notice of being handled; slight signs only of rickets; fontanelle open; 13 teeth. Begins to sit up; activity much improved; uses arms and legs, and rests on elbows. Interest shown in her surroundings; colour improved. Can stand up in cot; tissues firm; child active and intelligent; general development as for a child of 18 months; fontanelle almost closed; 16 teeth. Beginning to walk; traces only of rickets.	As for Case 7.	Three attacks of scurvy, at 16, 20, and 24 months. Ear discharge at 9 months. Tuberculous finger 12 to 15 months.

CHART 5.—Case 9, Victoria J., born May 12th, 1917. B., Breast milk. R.M., Raw milk. V., Vegetable food. F.J., Fruit juice (raw). C. i. Cod-liver oil with phosphorus given; C. ii, cod-liver oil and phosphorus discontinued. R. i, Butter given 10 grams daily; B. ii, butter increased to 20 grams daily. C. iii, Cod-liver oil given in addition, 10 grams daily.

month of breast-feeding received additions of diluted milk. From 4½ months old her diet was entirely artificial, and until the age of 9 months consisted of milk diluted two-thirds with sugar and cereal. Small amounts of full milk were also given. From 9 to 11 months of age (February and March, 1918) she received full milk and cereal food made with full milk. During the first year of life the weight curve became progressively flatter and departed more and more from the normal.

The second year of life (May, 1918, to May, 1919) was even less satisfactory than the first. The net increase in weight over the whole twelve months was negligible, and amounted to 200 grams, and the year was marked by three attacks of scurvy.

The diet for the first month of this period contained a large proportion of "malt-soup," but in June, 1918, there is a record of full raw milk given for a few weeks, indicating that a scorbutic condition was suspected, although no symptoms are noted in her dossier. The diet then reverted again to ordinary milk and cereal food, until, at the end of August, 1918 (at 13½ months) malt-soup again made its appearance in the diet, with the addition of 100 grams daily of raw milk. In spite of this antiscorbutic addition definite scurvy was diagnosed in September (at 16 months). Fruit juice was given, and the diet was again changed to raw full milk, which was continued, with a short interval, until December, 1918. A cooked diet was then given of whole milk and cereal. Vegetables were included, but in January, 1919 (at 20 months), definite scurvy symptoms were again noted in the form of swollen gums and swollen and painful legs. Raw apple juice and lemon juice and raw milk were given again, and the raw milk was continued until the beginning of March (1919). The acute symptoms had then disappeared, so the raw milk was again discontinued and replaced by malt-soup. At the beginning of May (the child was then 24 months old) definite scurvy was diagnosed for the third time, and on this occasion was more severe in character than on the two previous occasions. There were skin haemorrhages on the back and thigh, the thigh was sensitive and painful, the gums were swollen, there was oedema of both feet, and haematuria.

Note was made of rickets at 22 months, the child had only five teeth, and was evidently very backward.

The curative treatment of this third attack of scurvy consisted of lemon juice, green vegetables, and raw full milk, which on this occasion formed a large proportion of the total diet, and was continued for nearly six months. The child began to grow, and at 2½ years had increased from 5.9 to 7.9 kg. in weight. At this period the child was seen for the first time, and her condition is summarized in the table. She was 2½ years old, and, although very backward in general progress, showed no gross signs of rickets. The head was well ossified and properly developed, the fontanelle was wide but not soft, the chest was rather contracted, but the abdomen was flat. The legs were long and straight and the body well proportioned, the arms were very weak, and the wrists showed enlargement. The muscular power was extremely feeble, and the head could only be held up for a few minutes. The child was lethargic, unintelligent, and inactive.

The effect of a combination of antiscorbutic and fat-soluble accessory factors is well shown in the progress made when raw lemon and orange juice 10 to 20 grams, and 10 to 20 grams of butter were added to the diet (see Table). Later 20 grams daily of swede-turnip juice was substituted for orange juice. In six weeks the child was trying to sit up; in three months she could do so, and was trying to stand; she also showed activity and intelligence in many ways. In five months she was beginning to walk with help.

This case is in many ways the most instructive of the series. First, it shows very clearly the inhibition of

growth and progress imposed by a scorbutic or pre-scorbutic condition, even when definite symptoms were absent. In the second place, the history of the second year of this child's life shows that scurvy must not be considered as cured when the severe symptoms are no longer obvious. The curative treatment for the first two attacks was applied for a short period and discontinued when symptoms had disappeared; on both occasions a speedy relapse took place. Only after the third attack of scurvy was the antiscorbutic treatment continued for a prolonged period, when the child showed by its growth that the constitutional disturbance was being really rectified.

CONCLUSIONS.

It is not possible to make generalizations upon the history of nine children, but the following provisional conclusions are stated here in the hope of suggesting further research in this field:

1. The addition of antiscorbutic juices and of fats containing the fat-soluble accessory factor was found to have a satisfactory result in stimulating growth and progress of nine very backward children, of ages varying from 12 to 31 months. The condition of these children before treatment showed that development had been retarded for many months.

2. The diet allotted for the children did not appear to be lacking in calories, but there was evidence that their food had been deficient in antiscorbutic principle and in milk fat.

3. It appears that deficiency of antiscorbutic material in diet had been an important cause of failure to grow. Eight of the nine children gave a history of previous attacks of definite scurvy, and two (Cases 4 and 6) showed bony deformities which were probably of scorbutic origin.

4. It is not possible to determine whether the beneficial effect observed after enriching the diet with two accessory factors is to be attributed to the extra antiscorbutic or to the extra fat given; probably both factors were concerned. In some instances—for example, Cases 4A and 8—improvement in growth and remission of rachitic symptoms were observed after addition of antiscorbutic material to a diet already containing a fair allowance of milk fat.

5. The cases studied indicate that the child's capacity for recovery is considerable when conditions of deprivation are rectified; the normal standard could be approached in six to twelve months, even after twenty-four months of retardation in growth and progress.

In conclusion, our warm thanks are due to Dr. G. Riether, Director of the Landes Zentral Kinderheim, for hospitality afforded to us in the wards of the institution and for permission to publish these observations. We also wish to express our indebtedness to Primarius Dr. M. Zarfl, physician-in-charge of the section in which these observations were made, for his continued co-operation and sympathy with us in our work.

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