inferior internal articular arteries will require ligation. The inner head of the gastrocnemius is isolated, divided at its origin, and the muscle turned down. The fatty mass is then pushed to the outer side until the azygos vessels are seen perforating the joint capsule; these are divided between forceps and ligatured, and it is then found that by retraction and further dissection the entire mass, which includes vessels and nerves, is freed from the posterior aspect of the joint which is now in full view. In two cases there was no shortening of the hamstrings at all; in fact it was difficult to differentiate the muscles on account of the fatty degeneration, and section of the muscles was solely undertaken to get a better view of the ligament of Winslow. Transverse section of the capsule is accompanied by forcible extension of the leg by the assistant; it is found that no very definite extension is gained until the posterior ligament is fully divided from side to side; this section includes the short external lateral ligament and the tendon of the popliteus. I have not yet satisfied myself as to whether the popliteus is ever a deforming factor, as I have never seen the flexion deformity combined with internal rotation of the leg. The posterior articular surfaces of the femoral condyles now appear in the capsular wound, which becomes elliptical in shape as the result of extension of the leg. The posterior crucial ligament is now seen as a tight band which prevents full extension of the joint; on section of this ligament the limb easily extends, often by its own weight. It is sometimes necessary to dissect out the popliteal nerves from the fat mass to enable them to take a more superficial and direct course. The popliteal artery rarely appears tense, circulation in the foot generally returning within a few minutes. In only one case have we had to delay full extension for a day or two; here the last 20 degrees was obtained in this space of time by the use of gradual extension on a bed splint. The case is nursed for a fortnight in a bed splint, and when the sutures are removed the limb is encased in plaster; the hip and foot deformities are subsequently treated as has been stated. The shortening varies from 1 in. to 4 in., and the patient is taught to walk with a high boot and calliper. Passive movements of the knee are encouraged in all cases, so that in adults a jointed calliper can be substituted later. In one case manipulation under an anaesthetic was required to produce knee flexion beyond 60 degrees.

The operation is one of simplicity, and the only points that I wish to emphasize are:

(a) Section of the inner head of the gastrocnemius and the mobilization of the vessels and nerves to the outer side of the joint. The weakening of the gastrocnemius does not appear to have any detrimental effect later and no calcaneus deformity has arisen in connexion with foot stabilization.

(b) The division of the whole of the posterior ligament from side to side, and more particularly the importance of section of the posterior crucial ligament, which I regard as a prime deforming factor.

Table of Cases.

Case.	Initials.	Sex.	Age.	Limbs Affected and Duration.
1	G. H.	M.	10	Both legs useless from birth.
2	K. H.	F.	10	Both legs useless from birth.
3	J.	F.	35	Left; fifteen months.
4	F.	F.	24	Right; onset at age of 4 years.
5	H.	F.	36	Right; six years.
6	A. H.	M.	41	Right; onset at age of 7 years.
7	C. W.	M.	14	Right; two years.
8	E. J. M.	M.	12	Right; onset at age of 7 years.
9	H. W.	M.	12	Left; one year.
10	H. M.	M.	15	Right; onset at age of 3½ years.
11	G. M.	F.	14	Right; onset at age of 3 years. (In hospital.)
12	H. M.	F.	14	Both; never walked right. (In hospital.)
13	R. W.	F.	19	Right; onset at age of 2½ years. (In hospital.)
14	M. D.	F.	22	Left; onset at age of 15 months.

THE THEORETICAL FOOD REQUIREMENTS OF INFANTS.

BY

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THERE seems to be a great diversity of opinion regarding the food requirements of infants during the first year of life. This is probably due to the fact that during this period the infant can only give expression to its needs in a very inadequate manner. There can be no doubt that many infants are underfed, while others are greatly overfed. Overfeeding is, however, probably less common than underfeeding, because usually unmistakable signs of gastrointestinal disturbance are displayed before overfeeding has been persisted in for any length of time. With underfeeding, on the other hand, the signs are less striking and appear more gradually.

Most of the textbooks on pediatrics give instructions regarding the nature and composition of the food that should be given, but there is a very striking variation in the quantity recommended by different authors. For example, Still¹ advises that at 3 months of age an infant should be fed six times a day with a milk mixture containing milk 1½ oz., cream (48 per cent.) 1 drachm, and sugar 1 drachm, such a diet being equal to about 400 calories a day. Hutchison² would give a child of the same age

FIG. 1.—The basal metabolism of infants under 1 year per kilo of expected weight and degree of emaciation.

seven feeds consisting of milk 1½ oz. and sugar 1 drachm, equal to 300 calories a day; while Thomson¹³ recommends milk 4½ oz. seven times a day, equal to about 600 calories a day, and the figure suggested by Holt⁷ is 560 calories a day. Thus Hutchison would give a diet with only half the number of calories that Thomson suggests, while Still takes an intermediate position. Lusk⁹ justly says: "The so-called 'scientific feeding' of infants is unworthy of the name unless the caloric requirement is carefully considered. From lack of this knowledge babies are frequently systematically starved." For this reason and from the fact that there seem to be such divergent views on the subject, an attempt has been made, by utilizing the results of metabolic experiments, to indicate the ideal requirements of infants in various stages of malnutrition. Similar figures have been suggested by both Talbot¹¹ and Holt,⁶ but both these have confined themselves to the requirements of the normal infant, and although the total requirements suggested by Talbot agree fairly closely with those suggested in this paper there are considerable differences in the amounts allocated to the various processes the sum of which makes up the total requirements.

It has long been recognized that infants should be given quantities of food suitable for their age rather than for their actual weight¹⁰; in other words, they should be fed according to the weight they should be for their age (the expected weight) rather than according to their actual weight. Studies of the basal metabolism² have confirmed this view up to a certain point, for it has been shown that the basal metabolism of infants who are within 35 per cent. of the expected weight is as high as that of infants

of normal weight. When, however, more than 35 per cent. of the expected weight has been lost the basal metabolism rate is found to decrease *pari passu* with the degree of emaciation. It seems probable, therefore, that in the graver stages of emaciation a smaller amount of nourishment should be given than the amount necessary for a well nourished child of the same age (Fig. 1). In estimating the food requirements other factors beside the basal have to be taken into consideration. These are the amount lost in the excreta, the amount added to the body in growth, and the amount used in muscular exertion.

Basal Food Requirements.

The basal requirements of normal children under 1 year of age are 55 calories per kilo of expected weight. After one-third of the expected weight has been lost the basal requirements grow less, and, as shown in Fig. 1, when an infant is only half the weight it should be the basal requirements are only about 40 calories per kilo of expected weight. This curve has been compiled from a large number of observations made by Benedict and Talbot¹ and the author,² on children in all stages of nutrition ranging from 20 per cent. above normal weight to 70 per cent. below normal weight.

Amount of Food Lost in the Excreta.

This is usually computed at 10 per cent. of the basal requirements, but is dependent to some extent on the quantity of food taken. Consequently in emaciated infants who are receiving a diet adjusted according to the expected weight but who have a relatively low basal metabolism on account of emaciation, this will possibly be considerably more than 10 per cent. of the basal, and 20 per cent. of the basal requirements is the figure suggested for infants who are 70 per cent. below the expected weight. This is shown in Fig. 2.

Amount of Food Required for Growth.

Only the actual amount of food stored in the body is included under this heading. If there is any expenditure of energy in manufacturing new tissue this must be included in the basal figures, for it is extremely improbable that a child ceases to grow while it is in a calorimeter having its basal metabolism examined. With normal growth it can be calculated that during the first year of life tissue of an average value of about 5 calories per kilo of weight is added daily to the body of the growing infant.³ Emaciated infants who are gaining weight rapidly may add larger amounts, so the requirements under this heading for emaciated infants have been increased slightly, and at 70 per cent. below expected weight 10 calories are allowed for this (Fig. 2).

Amount of Food Required for Muscular Exertion.

It is impossible to give any hard and fast figure for this, but it is probable that for the healthy child about 35 calories per kilo of expected weight are sufficient. Talbot¹² examined the metabolism of two children, each for about twenty-two hours out of twenty-four; and he found that the heat output for twenty-four hours in the younger was 68 calories per kilo of expected weight, and in the older 55 calories per kilo of expected weight. If the probable amounts lost in the excreta and added to the body in growth be also taken into account the heat output of the younger is found to have been 78 calories and the older 62 calories per kilo of expected weight. These figures are surprisingly low, but it is probable that, confined as the infants were in the respiratory chamber, a considerably smaller amount of energy was expended than if they had been living their normal life. By muscular exertion, crying, etc., a normal infant raises its metabolism greatly, and an increase of 65 per cent. above the basal has been allowed for this. This entails an addition of 35 calories per kilo of expected weight, and brings the total requirements to 100 calories per kilo of expected weight (Fig. 2). It must be remembered, however, that the atrophic infant does not show the same vigour as the

healthy, and in view of this a smaller allowance has been given for muscular exertion as emaciation increases, so that at 70 per cent. below expected weight only 20 calories have been allocated under this heading. The sum of these four allowances gives us the total caloric requirements for twenty-four hours for children under 1 year with varying degrees of malnutrition (Fig. 2).

FIG. 2.—Caloric requirements of infants under 1 year of age.

Heubner⁵ considered that at birth 100 calories per kilo should be given, and at 9 months of age only 70 calories per kilo. In view of the fact that it has been shown that the basal requirements are practically the same per kilo from 1 month of age till the end of the first year,¹ that the loss by excreta is practically the same, and that though there is a decrease in rapidity of growth (a small item) there is an enormous increase in muscular activity, it does not seem justifiable to give relatively less nourishment to infants of 1 year old than to infants of 1 month old. It must be borne in mind, however, that there are great individual variations, and, moreover, that the calculations presented are not exact, especially regarding muscular exertion, for there must be a variation of at least 25 per cent. in the muscular energy expended by infants. For this reason some infants may require less nourishment than others; few, however, should require more than the amounts suggested.

The nature of the food and the balancing of the diet have not been considered in this paper. Only the caloric requirements based on metabolic findings are dealt with; for until these are established there can be little use in discussing whether more or less carbohydrate or fat or protein or vitamin should be given. Let us first decide how much to give the infant, and then consider in what form it should be given.

Conclusion.

It is suggested that during the first year of life infants who are within 30 per cent. of the expected weight for the age should receive a diet of a value of 100 calories per kilo of expected weight per diem, and that below this a diet of gradually decreasing caloric value should be given.

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