

A STUDY OF THE CALORIC NEEDS OF PREMATURE INFANTS.

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VIERORDT and Rubner were the first to investigate the metabolism of the infant. Camerer, in 1889, collected a large amount of material and endeavored to determine in heat units the nutritive needs of infants of various ages. He calculated the caloric contents of breast milk on the basis of Pfeiffer's analyses. A considerable number of observations have been made by different men since that time. Each one has, as a rule, made but one or two. Most of them have been made on breast-fed infants; a few on artificially fed. Some of them have extended over the first year, but most of them only over short periods of time. Czerny and Keller, in their hand-book published in 1902, have reviewed the work of previous observers in detail and added a considerable amount of material of their own. Since then Beuthner has studied three cases, one of which was fed entirely on breast milk, the others partly on breast milk and partly on artificial food. In 1902 he summed up the cases fed on breast milk hitherto studied in private practice. He included the cases of Ahlfeldt (2), Camerer (4), Feer (3), Hähner (4), Laure (1), Pfeiffer (2), Weigelin (1), Oppenheimer (1), and his own (3). The average number of calories per kilo taken daily was as follows:

1 week	59 calories.	10 weeks	104 calories.
2 weeks	100 "	14 "	96 "
4 "	106 "	17 "	91 "
7 "	114 "	20 "	85 "

In all these experiments the caloric worth of the nourishment was reckoned on the usual basis that 1 gram of albumin equals 4.1 calories, 1 gram of carbohydrates 4.1 calories, and 1 gram of fat 9.3 calories. There must be some doubt, of course, whether these figures, which were calculated expressly for the mixed food of a man, can be used in estimating the nutritive value of milk for an infant. In the mixed diet of the adult about 8 per cent. of the total worth is lost in the feces. Czerny and Keller have shown that this loss is much less in healthy children fed on milk. All these observers estimated the caloric value of human milk at 650 calories per litre, and of cow's milk at 670 calories per litre. This standard for the caloric contents of woman's milk is based on an estimated composition. Everyone knows that the milk of different women varies, especially in its fat contents, and that the milk of the same woman varies from day to day and from nursing to nursing. These physiological variations in the composition of woman's milk make an average caloric worth elusory. This average figure is still more elusory when we realize that the accepted caloric value of 650 calories per litre is based on the average of the analyses of the milk of two women, one of whom had a milk poor in fat, the other a milk rich in fat. Schlossmann, moreover, obtained as the result of 218 analyses of woman's milk an average value of 782 calories per litre. He used this figure as the basis of his investigations. It is evident that the figures of previous observers will be materially altered if this caloric value is accepted. It is evident, therefore, that figures based on such an average caloric value per litre of milk cannot be of great value.

Heubner draws the following conclusions from the cases of Feer, Finkelstein, Camerer, and others: An alimentation whose quotient of energy does not exceed 70 calories is insufficient for an infant, even if breast-fed, to prosper on, at least during the first six months. In order to get a normal gain a quotient of energy of at least 100 calories with natural alimentation and of 120 with artificial alimentation is necessary. After the sixth month a given quotient of energy gives better results as regards gain in weight than in the first six months; that is to say, in the second half of the first year the organism works more economically than at the beginning of life. In order to obtain the same results a larger quotient of energy is required in artificial alimentation than in natural alimentation. He believes that the less favorable results of artificial food are due to the greater work which cow's milk imposes on the digestive organs. This work absorbs a certain number of calories which normally are made use of by the organism. Other writers have attributed the difference in the results to the difference in the casein of woman's and cow's milk.

In attempting to determine how much nourishment a healthy suckling needs it is of the greatest importance to determine by

what standard the amount of this need is to be measured. In adults under physiological conditions enough nourishment must be taken to keep up the weight. This is not sufficient for infants in the first year, who must take enough nourishment to make possible a gain in body substance. This gain must also be of a certain definite kind. A gain in weight alone is not sufficient and cannot be accepted as a reliable guide to the worth of the food. At present we are not in a position to say what substances and what quantities of these substances are necessary to meet the loss of the body and to make possible a normal gain in development. We do know that the infant must have albumin, but that it can thrive on a comparatively small amount. Whether fat or carbohydrates can be omitted without causing harm to the organism has not yet been determined in the healthy infant. Single observations on sick children point to an affirmative answer.

The number of experiments which have thus far been made in the metabolism of infancy are too small to justify any general and sweeping conclusions. It must be remembered, moreover, that figures based on an average caloric contents of milk show nothing more than does the quantity of the nourishment. A study of the curve of nourishment in healthy infants shows in the beginning for a longer or shorter time a daily increase in the amount of milk taken, which increase, nevertheless, steadily diminishes as the infant becomes older. In the first weeks of life, in breast-fed children, the amount of nourishment taken is about one-fifth of the body weight. It gradually diminishes and from the middle of the first to the middle of the second quarter-year remains between one-sixth and one-seventh, and at the end of the first half-year is about one-eighth of the body weight.

The variations in the rate of development of children who take the same quantity of woman's milk may be largely explained by the differences in the chemical composition of the milk which they receive. Moreover, as the result of the variations in the area of the surface of the body different percentages of the energy taken in are given off in the form of heat. Finally, it is possible that the differences in the composition of the body substance in different children may play a part.

Czerny and Keller think that the figures which have been obtained by averaging the number of calories taken by the various infants which have been studied are larger than the nutritive need of a healthy infant. One of the infants studied in their clinic shows that Heubner's assumption that an intake of less than 70 calories per kilo, even in breast-fed infants, is not consistent with a normal increase in weight for the first half-year is erroneous. In this case less than 70 calories per kilo were taken for six weeks. The increase in weight was, nevertheless, 15 grams daily. They also give various observations which show that in breast-fed infants less than 100

calories per kilo is completely sufficient for a satisfactory development.

They do not agree with Heubner's assertion that with an artificial food satisfactory development is impossible on less than 120 calories per kilo daily. Heubner based his opinion on Finkelstein's study of a healthy infant. Another case of Finkelstein's which was also on an artificial food did well and gained regularly on much less than 120 calories per kilo, taking an average of 103.6 calories per kilo in the first quarter-year, 102.5 in the second quarter, and 99 in the third quarter. They consider that the quantity of milk necessary to give 120 calories per kilo of body weight is overfeeding.

They do not agree with Heubner that a larger caloric worth of cow's milk is necessary than of breast milk. They state that metabolism experiments have thrown but little light on the comparative nutritive worth of woman's and cow's milk for healthy infants. (They quote Rubner and Heubner's experiments.) These show no important differences as regards the utilization of the constituents of cow's and woman's milk, the physiological results being almost the same in both cases. They assert that the caloric need of a healthy infant is no greater when nourished on cow's milk than on human milk, and that the assumption that when cow's milk is taken more of the energy ingested is used up by the digestive tract than when breast milk is taken is therefore unwarranted.

It is a well-known fact that small bodies have a greater surface area in proportion to their mass than have large bodies. The loss of heat is therefore relatively greater in proportion to the weight in small than in large bodies. Rubner first recognized the importance of this fact in relation to tissue changes in living animals, and demonstrated that the tissue changes are proportional at every age to the size of the surface of the body. Young individuals, therefore, show a relatively greater destruction of material than older, and hence require relatively larger amounts of nourishment. This difference in size explains to a certain extent, but not entirely, the far greater number of calories per kilo required by infants than by adults in order to thrive. The rest of the infant's greater requirement is accounted for by the fact that the infant uses up a considerable amount of energy in growth.

Reasoning on the same lines, premature infants, being so small, should require even more calories per kilo than full-term infants in order to thrive. Heubner compared an artificially-fed premature infant studied by Finkelstein with a breast-fed full-term infant studied by Feer and another artificially-fed full-term infant studied by Finkelstein, and found that it did not do so well as the others. Its gain was only one-half as rapid as that of the artificially-fed infant, although after the sixth week it took as many or more calories per kilo of weight. During the first three weeks it took an average of 25 calories per kilo and made no gain, while in the

two weeks following it took between 50 and 90 calories per kilo and made a slight gain. During the next four weeks it took an average of 104 calories per kilo, and from the tenth to the seventeenth weeks inclusive 135 calories per kilo. It averaged 120 calories per kilo from the eighteenth to the thirty-ninth week inclusive, and 107 calories per kilo from the fortieth to the fifty-second week. During the first quarter of the year it made an average daily gain of 12 grams, in the second one of 18 grams, in the third one of 15 grams, and in the last one of 2 grams. Its initial weight was 1350 grams, while at the end of the year its weight was 5750 grams. It was fed on peptonized milk.

Heubner explains the smaller gain on a relatively equal or greater intake of energy on the principles detailed above. Another possible reason why premature infants might be expected to require a relatively greater intake of energy lies in the comparatively undeveloped condition of the digestive power which results in a less complete utilization of the food ingested. No proof of this latter assumption is, however, at hand.

Beuthner studied an infant six or seven weeks premature for twenty-five weeks. It was entirely breast-fed for seven weeks, and was then given in addition cow's milk diluted with a cereal decoction to the end of the twenty-fifth week, at which time the observation was discontinued. It weighed 2400 grams at birth and 6800 grams at the end of the twenty-fifth week, having made an average daily gain of 25 grams. During the first quarter it took a daily average of 113.1 calories per kilo, and during the second quarter one of 92.2 calories per kilo.

Schlossmann studied an infant four or five weeks premature from the twelfth to the eightieth day. It was breast-fed. It weighed 2230 grams on the twelfth day and 3310 grams on the eightieth day, having made an average daily gain of 16 grams. It took an average of 119 calories per kilo daily and made an average daily gain of 5.5 grams per kilo.

These cases, as far as they go, confirm Heubner's assumption that premature infants require a relatively greater amount of nourishment than full-term infants, and that a larger number of calories is necessary in a substitute food than in breast milk. The differences are so slight, however, that but little importance can be attached to them.

During the past winter I have studied from the point of view of the quotient of energy the feeding of six premature infants, five of them at the Infants' Hospital and one in private practice. All were fed on modified cow's milk of definite percentages prepared at the Walker-Gordon Laboratory. The composition of the food being known, it was easy to calculate its caloric contents. It is possible that the composition of the food may not always have been exactly what it was supposed to be. Edsall's recent analyses of milk pre-

pared at the Walker-Gordon Laboratory show, however, that these variations must have been very small, certainly not large enough to have vitiated to any extent the value of the results. They certainly must be more accurate than those obtained on the basis of the average analyses of woman's and cow's milk. The amount of food taken at each feeding was carefully measured. The caloric value was calculated on the basis that 1 gram of sugar or proteids equals 4.1 calories, and 1 gram of fat 9.3 calories.

Unfortunately all the babies did not do uninterruptedly well. One died when twenty-seven days old, of a congenital cardiac lesion complicated by atelectasis of the lungs. Its digestion had been good from the first, however, and it had shown no signs of its cardiac or pulmonary lesions until its sudden collapse and death. One left the hospital when three weeks old, not gaining, but doing very well in other ways. Two did very well and gained steadily. One gained steadily for ten weeks and another for eight weeks, after which both had more or less disturbance of digestion and did not gain regularly, sometimes gaining and sometimes losing. Most of them showed a tendency to have too many dejections. These were, as a rule, of good color and odor, but were rather loose and contained fine curds. They did not seem to interfere with the gain in weight, but suggested that a portion of the food was not properly utilized. The histories with charts are given in more detail below:

Ruth C. was brought to the Infants' Hospital February 1, 1903, when six hours old. She was thought to be two months premature. The physical examination showed nothing abnormal. Her cry was strong. Her weight was 2500 grams. Her temperature was about normal during the whole of her stay in the hospital. She always took her food well and never vomited. She had from one to four movements daily, usually one or two, which were generally a little green and contained a few curds. The movements were not as good on February 12th. She was given calomel and her food was cut down for forty-eight hours. She was discharged February 22d at her parents' request. She had been taken out of the incubator and was doing well. Her weight was 2440 grams.

James McL. was admitted to the Infants' Hospital April 24, 1903, when twenty-four hours old. He was supposed to be two months premature. He was feeble and had a feeble cry. His extremities were cool. The heart sounds were normal, the rate slow. No further examination was made. His weight was 1170 grams. He was at once put in the incubator. His temperature remained subnormal until May 9th, after which it was irregular, but usually elevated. He took his food well from a Breck feeder, but was not able to take an ordinary nipple. He regurgitated a little during the last two or three days. During the first nine days he had one movement daily which, after the meconium was passed, was well digested. After that time he had from two to six move-

ments daily, usually well digested. They were well digested on the day of his death. He seemed to be doing finely until the weather suddenly became hot. He immediately began to fail and died May 20th. His weight on the day of his death was 1040 grams. The autopsy showed that both the foramen ovale and the ductus arteriosus were open and that portions of both lungs had never expanded.

CHART I.

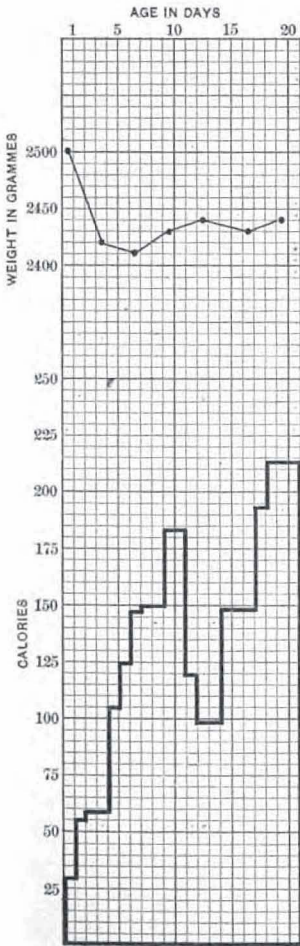
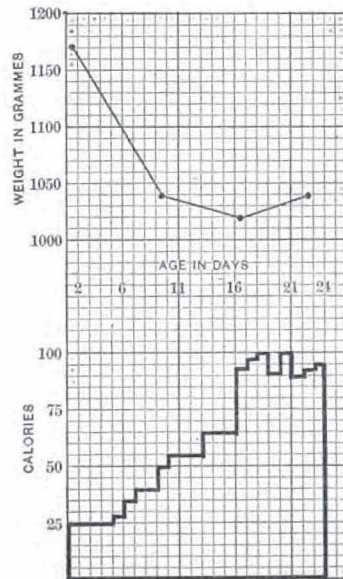


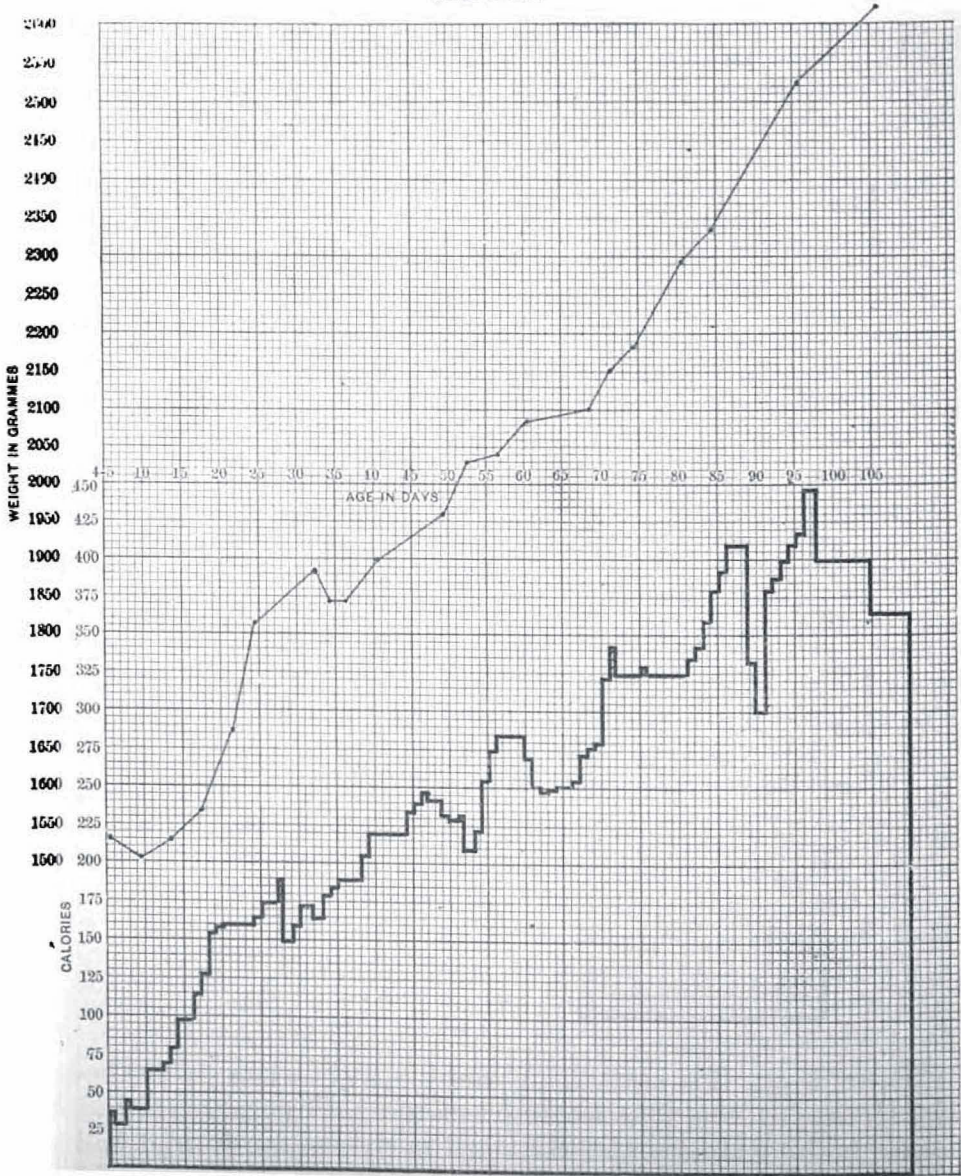
CHART II.



Charles S. was first seen on February 3, 1903 when twelve hours old. He was at least four weeks premature. Physical examination showed nothing abnormal. He acted fairly vigorously and had a strong cry. His weight was 1530 grams. He was put in a padded crib. When five days old he suddenly collapsed and almost died. After this he was feeble for a considerable time. At first he had to be fed with a Breck feeder and sometimes with a dropper. He usually took his food fairly well, but showed a tendency to spit it up if he were at all overfed. The food supply had to be cut down several times temporarily on this account. There was a slight tendency

to constipation, but the movements were, as a rule, well digested. He had a good deal of colic. The observation was stopped on May 19th, when he was fifteen weeks old, because the family were going into the country for the summer, where they had to use a home modification of milk. His weight at that time was 2620

CHART III.

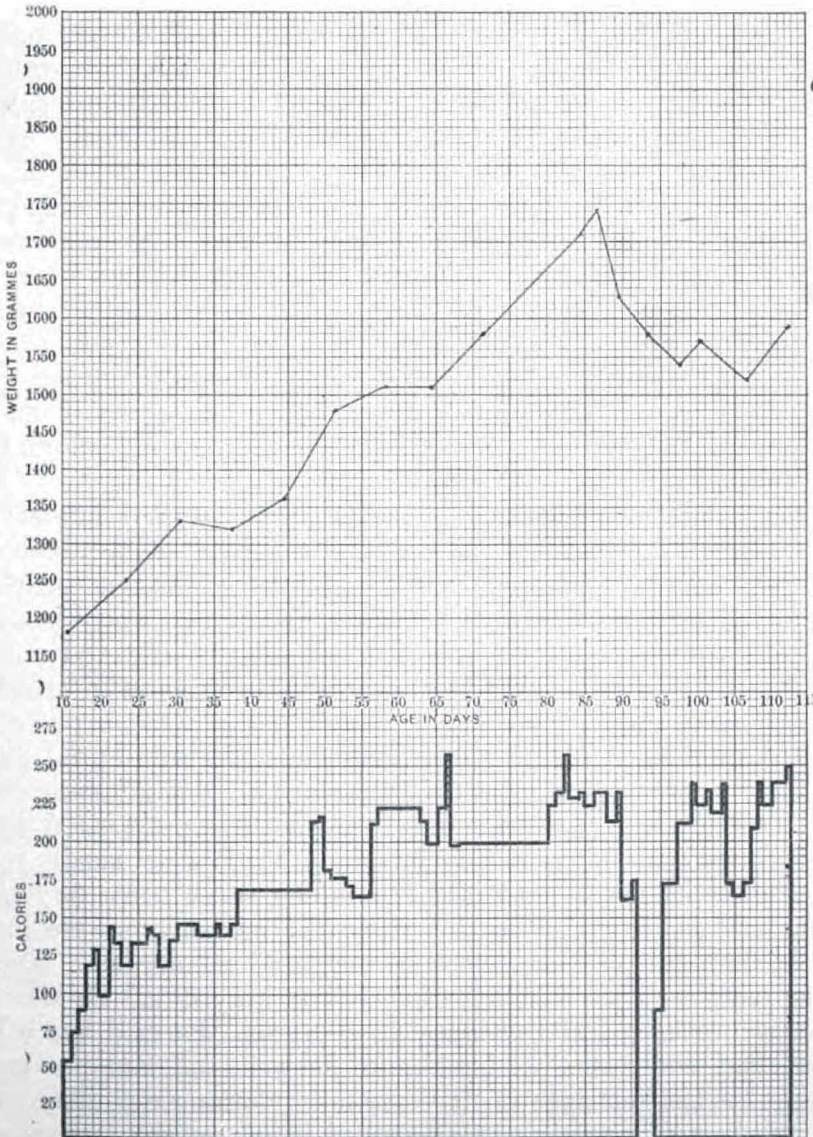


grams, making an average daily gain of a little over 10 grams. He was doing well at that time and has continued to do so.

Pauline J. was admitted to the Infants' Hospital March 20, 1903, when two weeks old. She was born at the Lying-in Hospital and had been in an incubator there before she came to the Infants' Hospital. She was supposed to have been about two months

premature. She was small, emaciated, and markedly jaundiced. The fontanelle was depressed, and the cranial bones overlapped. The physical examination showed nothing else abnormal. Her cry was strong. Her weight was 1180 grams. She was kept in an incubator until April 25th, and would have been kept there longer

CHART IV.



if the incubator had not been needed for another baby. She was kept in a padded crib until the middle of June. She was first bathed and dressed May 18th. Her temperature was usually normal or a little above normal. She was fed partly with a dropper and partly with a Breck feeder until March 24th, then with a Breck feeder until April 23d, after which she took the nipple. She usually

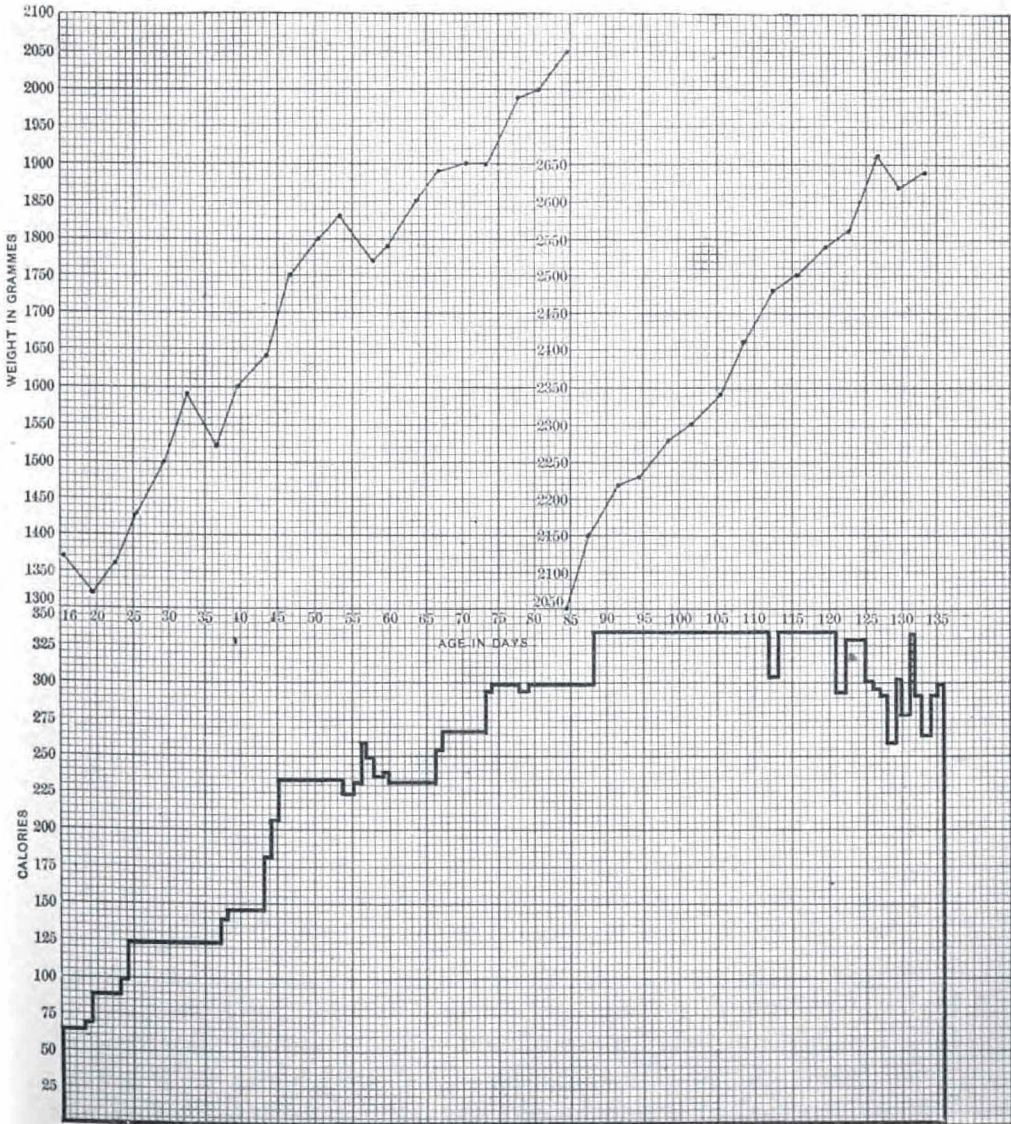
took her food fairly well. She did not vomit at all until about the second week in May, after which she at times vomited a good deal and at others not at all. On this account the food supply had to be cut down on several occasions and at one time milk was omitted entirely. After May 1st there was a slight tendency to looseness of the bowels. At times she had as many as seven or eight in twenty-four hours. These were either yellowish or yellowish-green, with fine curds and occasionally a little mucus. The movements, however, on the whole, were not bad. They certainly did not interfere with her general condition or prevent her from gaining until June 1st, when she was twelve weeks old. She then weighed 1720 grams, having made an average daily gain of 8 grams. She did not do as well after the hot weather began in June, although she developed no new symptoms, did not vomit any more or have a greater number of movements. She was discharged June 29th, when sixteen and one-half weeks old, because the hospital was closing for the summer. At that time she was not doing very well, was having many movements and vomiting a little. Her weight was 1600 grams. She was evidently sick after June 1st, and hence her records from this date on can hardly be properly used in estimating the caloric need of a normal infant.

Emanuel B. was admitted to the Infants' Hospital January 17, 1903, when two weeks old. He was supposed to be about two months premature. He had spent the first two weeks in an incubator at the Lying-in Hospital. While there he vomited every few days and was constipated. The physical examination showed nothing abnormal. His weight was 1370 grams. He was put in a padded crib, dressed March 5th, bathed March 23d and taken out of the padded crib April 26th. His temperature was subnormal during the first two weeks, but after that was normal. He always took his food well and very seldom vomited, at one time not for ten weeks. He had from two to five movements daily, which were usually yellow but sometimes green, and often contained small curds and sometimes a little mucus. On the whole the movements were mostly satisfactory except that they were increased in number. He was doing fairly well when he left the hospital, May 19th. He was then nineteen weeks old and weighed 2640 grams. He had had a little fever, had not taken his food quite as well, and had not gained during his last ten days in the hospital. Nothing definitely wrong was made out, however. It is hardly fair, nevertheless, to consider him a well baby after May 9th. The last ten days should not be counted in drawing conclusions. From the fifteenth to the one hundred and twenty-fifth day he made an average daily gain of a little over 12 grams.

James J. was admitted to the Infants' Hospital January 22, 1903, when fourteen days old. He was supposed to have been one month premature. He spent the first two weeks in the Lying-in

Hospital. He was thin and the anterior fontanelle was somewhat depressed. The physical examination was otherwise negative. His weight was 1820 grams. He was put in a padded crib. He had to be fed with a Breck feeder until March 10th. He was bathed March 13th and taken out of the padded crib April 26th. His temperature was subnormal for nearly a month, after which it

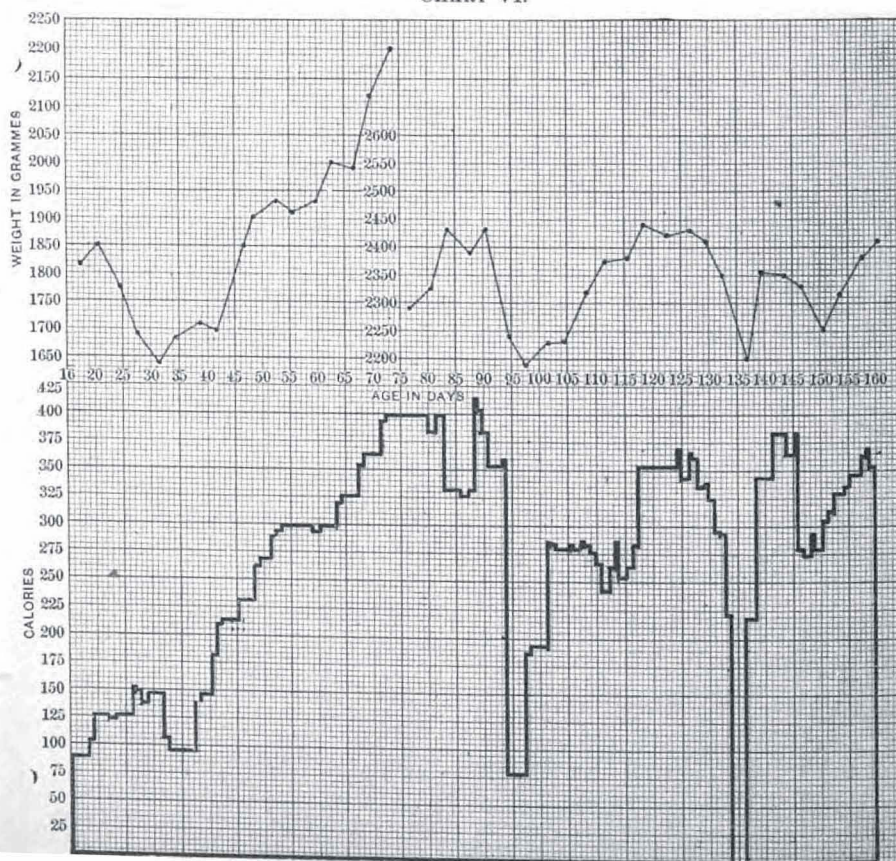
CHART V.



was usually about normal. He was never vigorous and never took his food very well. He did not vomit until the middle of May, after which he vomited occasionally. He had from two to four movements daily up to about the middle of March, after which he had too many movements, often as many as six or eight in twenty-

four hours. After April 1st, when he weighed 2430 grams, any attempt to increase the amount or strength of the food caused an increase in the number of movements. These movements were yellowish, or yellowish-green, and contained fine curds. On several occasions the food had to be cut down decidedly, and once milk was entirely omitted. During the last five weeks he had a sore mouth and tongue from time to time. He was much depressed by the first hot weather, which occurred in the middle of May. It was at that time that the milk had to be stopped. He never did as well afterward. He was discharged June 18th in fair condition and gained

CHART VI.



in weight. His mouth was well. He was taking his food rather better, was vomiting about once a day and having from three to four movements daily, some of which were normal and some of which were green and contained curds. His weight was 2410 grams. The only period in which he did almost uninterruptedly well was from the thirty-second to the eighty-third day. During this time he made an average daily gain of more than 15 grams. His subsequent record is of chief interest in showing the rapid fall in weight when the nourishment was cut down, with a correspondingly rapid rise when it was again increased. It is worthy of study in this connection.

Age in days.	Average calories per kilo ingested daily.						Average daily gain. Grams per kilo.						Number of cases.	Daily average calories per kilo.
	Groesman.	McLeod.	Stone.	Jeffrey.	Blakie.	Joyce.	Groesman.	McLeod.	Stone.	Jeffrey.	Blakie.	Joyce.		
1-5	24.8	20.5	...	...	...	...	lost	lost	...	...	...	...	2	22.6
5-10	61.7	34.5	33.6	...	...	...	even	lost	...	...	...	...	3	43.3
10-15	53.5	56.7	59.0	...	...	...	even	even	6.5	...	...	...	3	56.4
15-20	75.4	85.4	94.4	77.7	52.7	55.2	even	even	14.8	6.6	lost	2.2	6	73.5
20-25	...	72.1	95.1	100.8	72.5	70.3	...	even	17.0	8.0	13.1	lost	5	82.2
25-30	90.8	103.8	87.2	83.3	...	...	4.3	9.3	12.3	lost	4	91.3
30-35	98.5	109.0	82.8	72.4	...	...	lost	even	6.5	2.4	4	90.7
35-40	114.9	116.5	86.9	75.2	...	...	7.6	1.5	6.3	2.3	4	98.5
40-45	121.0	126.4	101.5	120.0	...	...	3.1	4.5	10.9	11.4	4	117.2
45-50	119.4	134.5	135.0	132.0	...	...	7.0	12.8	11.4	11.8	4	130.2
50-55	123.4	119.7	129.0	152.3	...	...	2.9	5.4	2.2	even	4	131.1
55-60	138.9	138.6	137.2	156.2	...	...	3.8	2.6	lost	2.0	4	141.5
60-65	120.3	143.0	122.7	158.6	...	...	even	even	6.1	6.1	4	136.1
65-70	147.9	141.5	137.2	170.3	...	...	6.6	7.7	4.2	12.6	4	149.2
70-75	151.0	126.1	145.5	180.6	...	...	6.4	6.3	2.0	9.2	4	150.8
75-80	145.9	122.3	152.4	176.2	...	...	8.0	6.0	7.1	8.8	4	149.2
80-85	161.3	121.3	157.2	166.5	...	...	5.1	6.5	6.2	8.4	4	149.2
85-90	152.6	134.3	148.1	149.5	...	...	7.4	lost	13.4	even	2	150.3
90-95	165.0	...	158.7	131.7	...	...	6.4	...	3.7	lost	2	161.8
95-100	160.4	129.3	148.5	64.8	...	...	3.9	even	4.4	lost	2	154.4
100-105	148.4	141.2	149.9	117.1	...	...	3.0	lost	4.3	1.8	2	146.6
105-110	130.3	140.7	124.0	...	...	...	2.5	8.4	8.7	1	140.7
110-115	133.7	112.1	...	...	...	...	4.8	4.2	1	133.7
115-120	138.7	185.5	...	...	...	...	4.1	4.1	1	138.7
120-125	124.4	146.0	...	...	...	...	6.2	even	1	124.4
125-130	110.8	145.5	...	...	...	...	even	lost		
130-135	11.4	...	...	...	...	...	1.5	...		
135-140		
140-145	153.7	...	...	...	...	...	even		
145-150	132.0	...	...	...	...	...	lost		
150-155	141.4	...	...	...	...	...	7.0		
155-160	150.9	...	...	...	...	...	5.9		

Further analysis of this table shows that these cases took from the fifteenth to the ninetieth day, that is, during the first quarter after the first two weeks, a daily average of 122.7 calories per kilo of weight, and that from the ninetieth to the one hundred and twenty-fifth day, that is, during the early part of the second quarter, a daily average of 142.9 calories per kilo of weight.

In the first few weeks these infants took less than the average given in Beuthner's table. As they did not gain at first it is probable, however, that in order to avoid upsetting the digestion they were somewhat underfed. These figures justify Heubner's assertions that not less than 70 calories per kilo are necessary during the first six months, and that with artificial alimentation at least 120 calories per kilo are necessary to get a normal gain. They correspond fairly closely with the results obtained by other observers in premature infants during the first three months, Beuthner's infant having averaged 113.1 calories per kilo, Schlossmann's 119 calories per kilo, and Finkelstein's 120 to 135 calories per kilo. In contradistinction to other figures they show a progressive increase in the quotient of energy toward the end of the first quarter and at the beginning of the second quarter. In spite of the high quotient of energy these

infants did not gain as rapidly as the average normal full-term infant, thus confirming Heubner's assumption that premature infants require a relatively greater amount of nourishment than do full-term infants.

It is very difficult to draw any very satisfactory conclusions from these figures. In some instances when two babies of the same age were taking almost exactly the same relative amount of nourishment one gained and the other lost. In other instances the baby taking the smaller amount of nourishment gained while the other lost. For example, between the fifteenth and twentieth days baby J. gained on 55.2 calories per kilo, while baby B. lost on 52.7 calories per kilo. Between the twentieth and twenty-fifth days baby B. made a large gain on 72.5 calories per kilo, while baby McL. just held his weight on 72.1 calories per kilo and baby J. lost on 70.3 calories. Between the thirtieth and thirty-fifth days baby J. gained on 72.4 calories, while baby S. lost on 98.5 calories. Between the fifty-fifth and sixtieth days babies S. and J. gained on 133.9 calories and 138.6 calories respectively, while baby B. lost on 137.2 calories.

In some cases in which two babies of the same age were taking practically the same relative amounts of nourishment, one gained two or three times as much as the other; for example, between the fortieth and forty-fifth days baby J. took a daily average of 120 calories per kilo and made a daily gain of 11.4 grams per kilo, while baby S. took 121 calories and gained only 3.1 grams per kilo.

Again, babies of the same age gained essentially the same amounts on widely differing amounts of nourishment; for example, between the seventieth and seventy-fifth days baby S. made an average daily gain of 6.4 grams per kilo on 151 calories per kilo, while baby J. gained 6.3 grams on 126.1 calories.

In other instances one baby did better than another for a time, and then a little later the second baby did better than the first; for example, between the twentieth and twenty-fifth days baby B. took 72.5 calories per kilo and gained 13.1 grams per kilo daily, while baby J. lost weight on 70.3 calories. Between the forty-fifth and fiftieth days baby B. took 135 calories per kilo and made a daily gain of 11.4 grams per kilo, while baby J. took 132 calories and gained 11.8 grams. Between the eightieth and eighty-fifth days baby B. took 157.2 calories and gained 6.2 grams, while baby J. took 156.5 calories and gained 8.4 grams.

Again, the same baby did not gain in proportion to the amount of food taken; for example, baby J., between the fortieth and forty-fifth days, took an average of 120 calories per kilo and made an average daily gain of 11.4 grams per kilo; between the forty-fifth and fiftieth days he took 132 calories and gained 11.8 grams; between the fiftieth and fifty-fifth days, 152.3 calories with no gain; between the fifty-fifth and sixtieth days, 156.2 calories with a gain of 2 grams; between the sixtieth and sixty-fifth days, 158.6 calories

with a gain of 6.1 grams; between the sixty-fifth and seventieth days, 170.3 calories with a gain of 12.6 grams, and between the seventieth and seventy-fifth days, 180.6 calories with a gain of 9.2 grams.

The only conclusion which it seems possible to draw from these contradictory figures is that the gain seemed to depend as much, or more, on the digestion and metabolism of the given baby at the given age as on the amount of the food, the age of the baby, or any inherent differences in the individual babies.

CONCLUSION. The conclusion seems justified from these figures that the caloric need of premature infants is relatively greater than that of full-term infants. This greater need is due in part to the small size and comparatively large surface area of premature infants, which cause them to lose heat faster than do larger, full-term infants, and partly to the incomplete development of their digestive powers, on account of which they utilize a relatively smaller proportion of the caloric value of the food ingested. This conclusion emphasizes the importance of protecting premature infants against loss of heat and of providing for them a food which will throw the least work on the partially developed digestive powers.

BIBLIOGRAPHY.

- Benthner. *Jahrb. f. Kinderheilk.*, 1902, vol. lvi. 446.
 Czerny and Keller. *Des Kindes Ernährung, Ernährungsstörungen u. Ernährungstherapie*, 1902, Abth. iii. u. iv.
 Heubner. *Zeitschr. f. Diätet. u. physik. Therap.*, 1901, vol. v. 13.
 Schlossmann. *Archiv f. Kinderheilk.*, 1902, vol xxxv. 339.