ALBUMIN-MILK IN INFANT FEEDING *

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I. LITERATURE

As the logical conclusion of many years of systematic effort to arrive at some definite ideas as to the nature of nutritional disturbances in artificially fed infants, with especial regard to the treatment, in May, 1910, Finkelstein and Meyer¹ first published their results with a new milk combination which, because of its high protein content, they named "eiweissmilch." Their reasons for preparing such a food are best given in their own words.

"The sugar (or rather, carbohydrate) is to be regarded as the essential and primary fermentation substratum without which as little a normal as a pathological acidification can take place. The fat can take part only secondarily, and then it is dangerous in the sense of acid fermentation only if the fermentation of the carbohydrates has previously begun. The fermentation of the sugar in turn is also dependent on various factors; first, whether the whey concentration is more or less suitable for the intestine, and as a result offers greater or less work for the intestinal epithelium; in the second place, on the proportion of the casein content contained in the mixture to that of the sugar. It is therefore clear that just as in the other rules of nutrition, so in regard to intestinal chemical action, the action of one food-stuff can never be estimated and judged by itself, but always and repeatedly the nature of the processes results from the quantitative proportions and the changing conditions of the whole of the organic and inorganic food-stuffs."

In endeavoring "to combat the dyspeptic fermentations" they decided that the following principles were necessary in the preparation of a food:

"Reducing the quantity of milk sugar; diminution of the salts by diluting the whey; enriching the casein with a changing, but, under certain conditions, not unmarked fat content; and after improvement is attained, the addition of a carbohydrate easily assimilable and consequently hard to ferment."

To meet these requisites they devised a food which had the following constituents:

Casein from 1 liter milk + $\frac{1}{2}$ liter buttermilk.
Fat from 1 liter milk.
Sugar from $\frac{1}{2}$ liter buttermilk.
Salts from $\frac{1}{2}$ liter buttermilk.

*Read before the Chicago Pediatric Society, May 22, 1911.

1. Finkelstein and Meyer: *Jahrb. f. Kinderh.*, 1910, lxxi, 655; *ibid* 683.

They advised the use of this food in

1. Dyspepsia.
2. Decomposition.
3. Intoxication.
4. Parenteral infections which have led to pathologic conditions in the gastrointestinal tract and therefore to nourishment disturbances of a secondary nature.
5. They wished to convince themselves of its use as a prophylactic for diarrheas in the new-born and very young children in the first weeks of life.

In all, thirty-three cases of dyspepsia were treated. In the beginning, after six hours of tea diet the albumin-milk was given to the amount of 300 c.c. in five to six meals as soon as the stool became normal, which was within three days; in thirty of the thirty-three cases the food was increased to the amount of 100 c.c. every second day until about 200 c.c. per kiloweight was given in twenty-four hours. If the stool was formed there was added Soxhlet's Nährzucker, Liebig's malt-soup or meal to the food. In most cases the decrease in weight had ceased by the third day and the general condition of the child was better. Of the sixteen cases which they were able to follow for an extensive period, only one showed a subsequent nutritional disturbance.

The number of cases of decomposition was thirty-six. The initial tea diet was continued for twelve hours and then the albumin-milk was given to the amount of 300 c.c. per day, the increase being more gradual. It required an average of about ten weeks to bring these children back to a normal tolerance for artificial milk. Of these patients, five died; three of collapse, one of bronchopneumonia and one of influenza. Sixteen infants were treated for intoxication. In these the tea diet was continued for twelve to twenty-four hours, after which albumin-milk was given in the amount of 5 c.c. ten times a day. This was increased rapidly, depending on the stools. A continuance for about eight weeks, on the average, was necessary for complete recovery. Of these sixteen infants, only one died.

Of twenty-six cases of new born, or only a few-weeks-old infants, two died, and in three it was necessary to resort to woman's milk. They do not advise the use of albumin-milk in these cases.

Of twenty-eight cases of severe parenteral infections, such as pneumonia, cystitis, influenza, sepsis, etc., six infants died, and they conclude that the albumin-milk has "an extraordinary influence in maintaining intact the nutritional functions."

Birk² soon afterward reported results in thirty mixed cases. In two of his cases the child was taken off of the albumin-milk for cause. In three very severe cases, death followed very soon after the beginning of nourishment with albumin-milk, and in two others death occurred very

2. Birk: *Monatschr. f. Kinderh.*, 1910, ix, 140.

suddenly while the children were on this food. Birk regards his results as very good. He was not able, however, after a certain time to cause the weight increase to continue in most cases without the addition of carbohydrates, and he is inclined to think that in those cases in which an increase was present without the carbohydrates, it was due to the high milk-sugar content in the food. He regards the food as fitted for intoxications (toxicoses) as well as chronic nutritional disturbances, but had some difficulty in changing from it to other foods. He thinks that the best results can be obtained if the total quantity of albumin-milk used is about one-fifth of the body weight.

Nothmann³ reported nine cases with one death and regards the use of albumin-milk as almost indispensable.

Contrary to these series of successes is the experience of Chapin.⁴ In twenty cases, in which eleven are characterized as atrophic, he had twelve deaths. In all his cases the ordinary percentage method had been previously employed without good results. He naturally is not well pleased with the use of albumin-milk in such cases.

Another article by Abt⁵ has appeared, explaining in detail the manner of preparation, indications and directions for the use of albumin-milk.

Braunmüller⁶ used albumin-milk in five cases of intoxication with four deaths (one of intercurrent pneumonia). He advises giving sugar only after a long interval, and instead to increase the starches.

Welde⁷ reports sixty infants nourished on albumin-milk; these may be tabulated as follows:

Pathologic Condition	Total Cases	Recovery	Unimproved	Deaths
Dyspepsia	25	23	2	0
Decomposition	20	16	0	4
Intoxication	3	2	0	1
Parenteral infections	8	6	0	2
Premature	1	1	0	0
Eczema	3	3	0	0

In concluding he says: "We take the stand that in our home, especially for seriously sick infants, the albumin-milk can no longer be dispensed with." And this in spite of the fact that he had trouble with the irregular composition of the mixture.

In a recent article Finkelstein and Meyer⁸ state that failure with albumin-milk is due to the following:

1. Injury to the child through inanition as a result of insufficient doses of the nourishment material in the beginning of the treatment.

3. Nothmann: *Jahrb. f. Kinderh.*, 1910, lxxii, 347.

4. Chapin: *Jour. Am. Med. Assn.*, 1910, lv, 1455.

5. Abt: *New York Med. Jour.*, 1911, xciii, 121.

6. Braunmüller: *München. med. Wehnschr.*, 1910, lvii, 2571.

7. Welde: *Therap. Monatschr.*, 1911, xxv, 83.

8. Finkelstein and Meyer: *München. med. Wehnschr.*, 1911, lvii, 340.

2. Injury in the beginning of the treatment due to too late or too small carbohydrate addition.

3. Injury by again withdrawing the carbohydrates or by too great reduction on recurrence of the nourishment disturbance in infants which were favorably influenced in the beginning.

They advise a rapid advance in the amount of albumin-milk given to 180 to 200 c.c. per kilo (about three ounces to the pound), or even more, and the increase of the carbohydrates to 5 to 7 per cent.; this increase to consist of Soxlet Nährzucker or Loefflund malt-soup or barley. The carbohydrate should under no conditions be reduced below 2 to 3 per cent., and the food should not be reduced unless the disturbances are severe. Albumin-milk must not be combined with other milk combinations.

II. METHOD OF PREPARATION AND USE

In all the cases reported in this article the albumin-milk was prepared in the infants' diet kitchen of Provident Hospital. The nurses here employed receive, previous to their service in this diet kitchen, a two months' service in the infants' diet kitchen of the South Side Free Dispensary. The albumin-milk was prepared by them in the following manner:

(1) Buttermilk: The original culture was made from lactone and the succeeding one by inoculation of new milk from a milk culture already twenty-four hours old; it was found advisable to run parallel cultures frequently since at times the original culture would spoil and produce a buttermilk which could not be used; (2) the curds: these were produced by adding a teaspoonful of chymogen (Armour and Co.) to a quart of *boiled* milk; allowed to stand one hour at about 40 C. and then drained through a sterile cheese-cloth bag for one and one-half hours. The curds thus obtained were put through a collander twice; (3) mixing: the curds were then mixed with a pint of buttermilk and water added to make one quart and the whole beaten thoroughly in a small churn.

When this process is completed, the albumin-milk should appear very much as does ordinary milk, except that when the bottle is slightly slanted, fine milk clots will be seen adherent to the glass. The difficulties in the manufacture of this food are many. In the first place, the buttermilk may become poor at any time and render it inadvisable to use it. Second, and a more frequent source of trouble, is the clotting of the curds in the bottom of the bottle in hard masses. To prevent this, several precautions are necessary. The milk after preparation must be cooled and kept cool until time for use; it should not be transported over long distances, but above all, in warming the bottle preparatory to giving the food to the baby, one must only heat it enough to take the chill off the food; in fact, in one of my cases the mother gave the child the food cold without any ill results whatever.

TABLE 1.—RESULTS OF FEEDING ALBUMIN-MILK IN NUTRITIONAL DISTURBANCES

Name	Age ¹ (months)	Diagnosis	Time on Alb. Milk (days)	Weight at Beginning (ounces)	Weight at End (ounces)	Average Weekly Gain (ounces)	Time of Ob. Before Alb. (days)	Gain During that Time (ounces)	Results		Carbohydrates	Colic	Vomiting	Constipation	Remarks
									Immediate	Remote	When Added (day)				
Roberts.....	4	Decomp.	10 100	89	—5	39	—29	Bad...	Bad...	Death.	6th malt-food.	++	—	—	Death from inanition.
Deris.....	7	Decomp.	81 142	209	+5	129	—30	Irrag. Good.	Good.	Good.	25th Malt-food.	++	—	—	Left hospital with whooping-cough.
E. Burns.....	8	Dysp.	46 178	159	+3	—	—	Good.	Good.	Good.	32d Malt-food.	++	—	—	Very severe case of gon. opth.
R. Burns.....	8	Decomp.	153 123	236	+5	—	—	Bad.	Good.	Good.	63d Malt-ext.	++	—	—	See Note 2.
Hill.....	4½	Dysp.	170 141	212	+3	8	—	Good.	Good.	Good.	7th Malt-food.	++	—	—	
Shuckler.....	13	Dysp.	51 300	317	+2	—	—	Irrag. Good.	Good.	Good.	22d Malt-food.	++	—	—	
Voller.....	2½	Intox.	45 116	167	+6	—	—	Good.	Good.	Good.	30th Malt-food.	—	—	—	Otitis media and pertussis.
Williams.....	2½	Dysp.	93 144	250	+4	—	—	Good.	Good.	Good.	28th Malt-food.	—	—	—	Very irregular on E. M.; died two weeks after last seen.
Hank.....	1½	Decomp.	21 204	121	+2	—	—	Good.	Good.	Good.	7th Barley...	—	—	—	Died two weeks after last seen.
R. Hackett.....	2½	Decomp.	10 87	78	—6	—	—	Bad...	Bad...	Bad...	—	—	—	—	Very poor reaction for six weeks.
Ruth H.....	2½	Decomp.	12 83	83	0	107	—13	Bad...	Bad...	Bad...	6th Malt-food.	—	—	—	Death.
Ford.....	7½	Decomp.	87 224	250	+2	—	—	Bad...	Good.	Good.	5th Malt-food; oatmeal.	—	—	—	
C. Smith.....	3½	Decomp.	10 123	116	—5	—	—	Fair.	Fair.	Death.	2d Malt-ext.	—	—	—	Mother ceased to bring child.
Oliver.....	5	Decomp.	29 143	141	0	—	—	Good.	Good.	Good.	12th Malt-sugar.	—	—	—	Otitis media.
Giffney.....	3	Decomp.	26 146	154	+2½	6	+1	Good.	Good.	Good.	4th Malt-food.	—	—	—	Still under observation? May 15.
Rome (A).....	2	Decomp.	7 126	135	—1	—	—	Fair.	Fair.	Fair.	4th Malt-ext.	—	—	—	Furunculosis of scalp; rickets; death about 1½ months after.
Rome (B).....	6	Decomp.	51 127	137	+1	21	—14	Bad...	Bad...	Bad...	42d Malt-food.	—	—	—	
Dailey.....	4		8 162	150	—12	—	—	Bad...	Bad...	Bad...	4th Malt-food.	—	—	—	
C. Smith.....	7½	Dysp....	40 170	201	+5	48	+12	Good.	Good.	Good.	Malt-ext.; malt-food.	++	—	—	Still under observation? May 15.
McD.....	1½	Decomp.	61 72	100	+3	42	—16	Good.	Good.	Good.	23d Malt-ext.	++	—	—	Developed pylorospasm later.
Bo.....	2½	Dysp....	7 144	137	—7	—	—	Bad.	Bad.	Bad.	—	++	—	—	Developed well on other food.
Hen.....	4	Decomp.	42 122	124	+1	30	6	Good.	Good.	Good.	3d Malt-ext.	++	—	—	
Woloszyn.....	4	Decomp.	11 121	119	—1	—	—	Good.	Good.	Good.	3d Malt-food.	—	—	—	Still under observation? May 15.
Gaston.....	½	New Born	23 121	131	+2½	—	—	Good.	Good.	Good.	5th Malt-ext.	+	—	—	Child in good condition when taken from hospital.
Pactse.....	7	Decomp.	12 140	132	—4	—	—	Good.	Good.	Fair...	3d Malt-ext.	—	—	—	Child in much better condition in spite of loss in weight.
Toomey.....	3	Decomp.	8 92	81	—8	—	—	Bad...	Bad...	Bad...	..	—	—	—	Death from erysipelas.

1. Age at time albumin-milk was first given.
2. At first given curds in barley water. Later period of fourteen days on skim milk and skim milk and curds of skim milk.
3. Twins; could not control mother.
4. A very strong suspicion of congenital syphilis in this case. A single convulsion with no return after mercurial treatment. Mother had iritis.
5. Failure due to attempt to introduce whole milk feeding, with loss of six ounces in five days.
6. This child at first seemed well, except for rickets and furunculosis of scalp.
7. Showed distinct improvement, with gain in weight varying from 6 ounces to 28 ounces since last observations recorded in table.
8. Child much worse on other milk mixtures. About one month after the albumin-milk feeding this child developed a scurvy, from which it finally recovered and was in excellent condition.

TABLE 2.—RESULTS OF FEEDING ALBUMIN-MILK IN PARENTERAL AFFECTIONS

Name	Age (months)	Time on Alb. Milk (days)	Weight at Beginning (ounces)	Weight at End (ounces)	Weekly Gain (ounces)	Colic	Vomiting	Constipation	Diagnosis	Results	Remarks
Walsh	6½	82	176	195	1½	—	—	—	Syph. hydroceph.	No improvement.	Child remained stationary on ordinary milk mixture.
Washington.	6	12	208	218	6	+	+	—	Cong. syph.	Improved.	
Spiles	10	7	140	117	—23	—	—	—	Anemia pseudo-infant.	Death	R. B. C., 1,900,000; W. B. C., 20,000; Hb., 40 per cent; Nuc. Red. of all varieties; enlarged spleen.
Graham	2½	91	111	101	—	—	—	—	Subcutaneous abscesses.	Death	During period when abscesses ceased to form child gained; on recurrence of abscesses child rapidly lost and died.
Gansleca	3	11	112	90	—14	—	—	—	Intestinal tuberculosis.	Death	At autopsy ulcers of intestine and rectum; enlarged mesenteric glands; under the microscope many tubercles.

III. COMPOSITION

According to Finkelstein and Meyer, the composition of albumin-milk in comparison with that of cow's milk is as follows:

	Albumin-Milk, Per cent.	Cow's Milk, Per cent.
Protein	3.0	3.0
Fat	2.5	3.5
Sugar	1.5	4.5
Ash	0.5	0.7

Birk states that in the albumin-milk used by him the protein varied from 1.9 to 2.6 per cent.; the sugar as high as 2.5, and once, 3.6 per cent.; on the average, 1.3 per cent.; the fat between 0.9 and 2.7 per cent., usually about 1.8 per cent. He thinks that the variation in the sugar content may account for the fact that "certain children showed unexpected increase in weight with unsweetened milk."

IV. AUTHOR'S CASES

This report consists of thirty cases, of which twenty-five are of nutritional disturbances (Table 1) and five of parenteral affections (Table 2). Of these cases, five were dyspepsias, with four recoveries and one failure; seventeen were decompositions, with two failures and three deaths. Of those classified as failures, both were cases which could not be controlled. Of the deaths, one was the first infant on which the albumin-milk was used and the albumin-milk period was preceded by a long period of decline; one death resulted from erysipelas. In one case of intoxication the infant made a beautiful recovery. In this case a modification of the albumin-milk was used. Instead of suspending the curds in the buttermilk, barley-water was used, and this in turn gradually replaced, an ounce or 2 ounces at a time, with buttermilk. In this case the above procedure did good service. One of the cases in this series was an infant a few days old, of comparatively good health, which thrived well on the food. Another case, aside from a rather severe rickets, and furunculosis of the scalp, showed no disturbance and yet went steadily down hill and died a month or six weeks after leaving the hospital. (Recorded as a death.)

Of the five cases of parenteral affections, three infants died, one was but slightly improved, while one made an excellent recovery. One of those which died had a very severe anemia pseudoleukemica infantum, one was afflicted with subcutaneous abscesses which were very bad at the start and cleared up entirely for some days, then began again and during the second attack the child died. The third was a case of intestinal tuberculosis. The infant which improved only a little was one with

syphilitic hydrocephalus; the other case was an ordinary case of congenital syphilis.

SUMMARY OF RESULTS

If we now review these cases we see that in twenty-five instances of nutritional disorder there were eighteen recoveries, three failures and four deaths. Of the deaths, *two* only were uncomplicated nutritional disorders. Of the failures, no infant was on the albumin-milk longer than twelve days, one being taken off the food because of a rather alarming loss of weight in the first week. When it is seen that such a large proportion of my patients were marantic and most of them under 4 months of age, it seems to me that the results are very good.

The cases to which albumin-milk was given were chosen because of their severe character or because of the age of the child. In no mild case in which it was thought that the infant would thrive on the usual milk mixtures was the albumin-milk given. This is shown by the fact that fifteen of the twenty-five cases were in infants 4 months or under.

There are certain symptoms which seem to be peculiarly the result of nourishment with albumin-milk. By most observers a subnormal temperature has seemed to be the rule in the cases of decomposition. This was so only in the more severe of my cases, but did not seem to me to be especially characteristic of nourishment with this food, nor did the addition of the carbohydrates seem to cause any great difference in the temperature curve. Vomiting and colic, with expulsion of flatus, were the rule, though in some cases these symptoms were conspicuously absent. Constipation was very frequent but could usually be controlled by the use of malt-food or malt-extract. The weight usually dropped in the first few days, but responded quickly and soon passed the original mark in the favorable cases. In some, the addition of carbohydrates was necessary to cause a gain in weight, while in others the gain occurred with the albumin alone or diluted with a small amount of thin barley-water.

Quite interesting was the rapid fall and rise of the weight-curve. This occurred usually in the more severe cases and often a drop of 4 to 5 ounces in twenty-four hours would be registered, with a quick return to a point above that before the drop.

Soon after the beginning of the albumin-milk nourishment the child is often pale and the tissue turgor, in instances in which it is possible to estimate it, may be reduced, but these soon come back to the original and I have never seen more healthy artificially fed infants than some of these which I have fed for months on albumin-milk.

In stopping the albumin-milk and changing to some other food, there is frequently great difficulty. If the loss of weight is so great that it becomes a danger to life, no recourse is left except to return to the

albumin-milk. It has been my custom to try a milk mixture, always preceded by at least two feedings of barley water. If this produced a rapid loss in weight, I immediately returned to the former mixture. In one case, in which an attempt at mixed feeding was made, my experience was that of others; i. e., that the two forms of food were not compatible.

For the failures here recorded, aside from the outside influences, such as disobedient attendant or parenteral affections, I can find no cause in the composition of the milk or in the absence or presence of carbohydrates. It has seemed to me, however, that a slight diarrhea is not an indication for reduction in the amount of albumin-milk, as it is in other mixtures.

As to why the albumin-milk, when properly made and properly dosed, gives such good results in many almost hopeless cases, it would be difficult to say. This milk as used has no reduction in fat or carbohydrates below the usual milk mixtures. It does, however, contain more protein and less of the salts. The large amount of protein must help to decrease the fermentation in the intestinal canal and thus inhibit one of the most disturbing influences of the carbohydrates.

At present the action of the salts individually and collectively is so little known that it is impossible to draw any conclusions in regard to them. At the same time, indications point strongly to a benefit from their reduction.

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