FEEDING TRIAL IN RELATION TO "EPIDEMIC ENTERITIS."

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THE possibility of using a practically sterile food for infants in relation to infantile summer diarrhoea, or "epidemic enteritis," has been considered from many points of view, all or most of the methods used starting with cow's milk as their basis.

Now as the case incidence of this disease in large town and crowded areas, as compared with rural districts, seems to be double, or practically so (11.5 against 5.0), it appeared probable that an experimental feeding of a number of infants living in their own homes, and in crowded and poverty-stricken districts, such as Bermondsey and Southwark, would be instructive both from a medical and bacteriological point of view, especially if the experiment were conducted during the summer months, in which the case incidence of this disease is highest.

It was with the object of collecting data with reference to this subject that some feeding trials were conducted with infants collected from various sources—the out-patient departments of Guy's Hospital, Royal Waterloo Hospital for Children, and the Surrey Dispensary. Special food was provided gratis for the use of selected infants in their own homes. The infants were brought up to the dispensary weekly, where they were weighed and medically inspected, while charts of their weight were carefully kept, together with notes as to the occurrence of rickets, scurvy, and especially diarrhoea.

The method employed was by using dried milk, of which there are several varieties on the market, prepared principally by German, French, and English firms, the last-named drawing their supplies from a particularly pure and carefully supervised source in New Zealand. Briefly, the method of preparing dried milk is as follows:

The cows are first inspected with reference to disease, such as tuberculosis, etc., by a veterinary officer. A contract is then made with the farmer, who undertakes to deliver the milk at the factory within three hours of milking. On receipt it is cooled by running over a cooler which has water at 50° F. running through it. Meanwhile the cans in which the milk was delivered are placed in a trough full of lime water; afterwards they are rinsed by being placed over a jet of cold water, and then over a jet of superheated steam, finally they are again rinsed with a jet of cold water before being returned to the farmer. A sample of the milk after cooling is now estimated for butter fat by Babcock's process, and farmers are paid in New Zealand for the milk on the basis of its butter-fat contents. Next the cooled milk is filtered by pressure through a filter composed of four prepared pieces of filter paper and a specially prepared cloth, to remove any dirt and filth present. I am informed that the amount of filth removed from even the most carefully collected samples is surprising. The mixed product having been again standardized to secure a product as nearly constant in composition as possible, the moisture is abstracted by allowing the milk to fall in a constant thin stream over revolving cylinders, heated by steam to a temperature of 240° F. The milk is in contact with the cylinders for about 2 seconds only. The dried powder is then removed mechanically and at once packed in hermetically sealed tins for export.

The efficiency of the process to destroy any organisms, whether pathogenic or otherwise, present in the original milk, may be inferred from the following passage occurring in Dr. Klein's description of several of his experiments: "Notwithstanding the prodigiously large number of specific organisms with which the sample had been infected by me, none of them could be detected after the milk had been subjected to this drying process."

The method I employed, which was found to be the easiest both from the distribution and feeding point of view, was as follows:

Each child, when first taken under treatment, was carefully weighed, then thoroughly examined with a view to rickets, scurvy, marasmus, etc. A chart was made out with notes, and a card given to the mother. To each mother was given a sealed tin of the milk, bearing printed instructions as to feeding, for easy reference; also a small measure holding roughly a drachm weight of the food, together with two bottles and a supply of teats, the latter of the variety that will fit over the neck of almost any bottle.

According to the infant's age the mother was instructed to put so many measures of the dried milk into the

bottle, previously rinsed out with boiling water, and then to fill up with boiling water to a mark made on the bottle with a file. This obviates all the trouble to the mother of weighing the powder or measuring the water. Roughly, 1 of powder to 7 of water is the strength of food we usually start with, and a table, as given below, is supplied for their guidance to the nurses who distribute the food.

Age of Infant.	Intervals of Day Feeding.	No. of Night Feeds.	Boiling Water.	Dried Milk.
1 week	2 hourly	2	1 oz. to 1½ oz.	1 measure.
2 to 3 weeks ...	2 hourly	2	2½ oz.	2 measures.
4 to 5 weeks ...	2 hourly	1	3 oz.	2 to 2½ measures.
6 to 12 weeks ...	2½ hourly	1	4 oz.	3 to 3½ measures.

and so on in about the same ratio.

No fixed quantity was given, the amounts being varied according to the results of observations by the medical officer, each child being prescribed for separately, and the food modified as occasion demanded. The mothers' attention was also drawn to the fact that, as some of the fat separates out and floats on the surface, the bottle requires shaking occasionally during a feed. Printed instructions were given to the mothers, and insisted on by the nurses, as to scalding bottles and teats when not in use, and also as to the importance of making each feed separately, and not keeping a feed, or part of one, from one feeding time to another. I prescribe, in addition, a small quantity of orange, or sweetened lemon juice to be given daily with a teaspoon after one of the feeds.

The results as to weight were most gratifying, the infants gaining in weight from 4 oz. up to 10 oz. weekly, the average weekly increase being about 6 oz. The worst drawback we have to contend with is the fact that the mothers will not bring up the children regularly to be weighed and inspected, even although the food, bottles, and teats are all supplied gratis. They will often miss several weeks at a stretch, and frequently drop off altogether after a few weeks, just as the child has begun to make progress.

With regard to chemical composition, I used two varieties of dried milk—the half cream and full cream—the difference, of course, consisting mainly in the amount of fat present.

As the experiment only ran for about eighteen or nineteen weeks, comparison of their respective merits cannot be made, the incidence of diarrhoea being the special object aimed at. The cost, if the mother had to buy the food herself, works out at roughly from 2d. to 4d. a day for a young infant.

Chemical Composition of one of the Samples known as "Full Cream," together with a Dilution of 1 to 7 with Water, Compared with Cow's Milk and Human Milk:

	Dry Powder.	Diluted 1 in 7 Water.	Cow's Milk.	Human Milk.
Milk proteids	22.2	2.7	3.7	1.5
Milk sugar	41.0	5.1	4.7	6.8
Butter fat	27.4	3.4	3.7	3.3
Salts	5.9	0.7	0.7	0.2
Moisture	3.5	88.1	87.2	88.2
Total solids		(11.9)	(12.8)	(11.8)

As will be seen by the above, dried milk diluted with water, 1 part to 7, nearly approximates to human milk as regards fats and sugar, the proteids and salts in lesser degree; when it is remembered that the composition of cow's milk may vary considerably in different samples—the fat alone varying from a minimum of 1.9 per cent. to a maximum of 6.9 per cent., and the total solids from 10 per cent. to 16 per cent.—the advantages of having a food with a definite chemical composition, which is always constant, is very great.

Acidity of Samples Examined.

Dried milk A, 10% sol.	100 c.cm. = 6.8 c.cu N/10 NaHO sol.
Dried milk B, 10% sol.	100 c.cm. = 4.4 " " "
Samples of ordinary milk taken :	100 c.cm. = 17 to 20 " " "

The ash of the dried milk Sample B after incineration gave no effervescence with HCl, nor could any evidence of the presence of boracic acid be detected.

With regard to the feeding value of dried milk, if the calorific value of its proteid, fat, and carbohydrate are worked out as such, a child, for instance, of, say, 10 lb. weight being fed every two hours during the day and two feeds at night would have sufficient calorific energy at its disposal to satisfy its requirements and a very liberal margin of nearly 200 foot tons to spare daily, the amount varying according to whether Voit's, Chittenden's, or another scale is taken as the standard.

The curds produced by solutions of the dried milk are extremely small, and vary slightly in consistence as to the kind of milk used, whether "half" or "full cream."

Experiments conducted with rennet as regards the clotting capacity gave the following results:

A sample of boiled cow's milk with rennet=thick solid curd.	
" unboiled " " =large heavy curds.	
" dried milk solution—1.7 (B) =very small curds.	

I also frequently examined the faeces of the infants fed on the dried milk, but could not detect any curds except in the case of the child suffering from diarrhoea, which was of the lenteric variety. Probably the citric acid, etc., in the fruit juice was largely responsible for the absence of curds; unfortunately I did not do a control feeding without the fruit juice.

The Bacteriology of Infantile Diarrhoea in Relation to Milk Feeding.

The following amoebae and bacteria have been isolated from the faeces of children suffering from this complaint: Amoebae, including *Paramoecium coli*, *Sarcomonas intestinalis*, and *Amoeba coli* (as far as I am aware, very little work has been done on these organisms, therefore I have neglected them), together with the moulds, etc., such as *Oidium albicans*, *Aspergillus glaucus*, *Penicillium glaucum*, and *Mucor mucedo*. The principal bacteria which have been isolated from the stools of children suffering from diarrhoea are noted below. Whether the diarrhoea is produced by the lactic acid fermentation caused by many of these organisms, or by direct absorption of toxins from the alimentary canal, is still a debated point. A brief glance at the actions of the commoner bacteria associated with infantile diarrhoea, on milk under laboratory conditions—that is, incubated at 37° C.—may be of interest.

B. coli forms acid, gas, and firm clot in litmus milk; it also ferments lactose, forming acid and gas.

B. dysenteriae turns litmus milk first acid and later alkaline, and does not ferment lactose.

B. enteritidis (Gaertner) usually turns litmus milk alkaline and does not affect lactose; but different strains of the bacillus act differently.

B. enteritidis sporogenes gives a very characteristic reaction with litmus milk. First, a large clot is formed; later this is broken up by the abundant gas formation, and an almost perfect separation into curds and whey takes place; the latter is acid, and swarms with the bacilli. As this organism is spore-bearing it would not be destroyed by pasteurization or raising to boiling point only, but apparently it is destroyed by the drying process.

B. butyricus (Bodkin) was isolated by Klein in 1895. It ferments lactose, forming acid and gas.

Morgan's No. 1 bacillus with litmus milk slowly gives alkaline reaction, does not change lactose, but with galactose forms acid and gas. It produces fatal diarrhoea in rabbits, rats, and monkeys fed on food contaminated with cultures of it.

Looking at the foregoing list of organisms, and their actions on milk, the staple diet of infants, it is at least feasible to assume that, presuming they are not present in the intestine (except, of course, *B. coli*, which is always present), the use of a sterile food during the diarrhoea season must be advantageous.

Even assuming the absolute necessity of symbiosis, as held by many authorities, there are plenty of organisms having their normal habitat in the intestine without introducing fresh ones of a highly pathogenic nature through the medium of filthy milk.

With reference to the weight increase, as previously mentioned, from 4 oz. to 6 oz. weekly, I think, it was not bad when it is remembered that none of the infants were normally healthy or well cared for. All were collected from the out-patient departments, all were children of the poorest and most neglected class; and all were suffering from one or other of the various ailments so common amongst this class of children, principally bronchitis, bronchopneumonia, marasmus, and in some cases diarrhoea, but the latter were, of course, not included in the report as to the incidence of same during the feeding, but a record kept only of their increase in weight after the diarrhoea had ceased.

Summary.

The trial lasted nineteen weeks altogether, during which 38 infants were supplied with the food gratis, and fed solely on it.

The length of time during which the children were under observation varied, some being brought up regularly every week for the whole time, and these did the best; on the other hand, others were only brought up for a week or two, and then were not seen again owing to the slackness of the mothers, or, perhaps, because they were too busy to spare the time to bring the children to the dispensary. During the whole period we had 5 cases of diarrhoea, but as 2 came to us already suffering from the complaint, and 2 contracted it at times when they were not being fed by us—that is to say, they ran out of food, and instead of coming up at once for a fresh supply the mother fed the infants for about a week on such substitutes as boiled bread and water, condensed milk, etc.—it is only fair to exclude these also. The only case I cannot account for is that of a child who was fed on dried milk solely from start to finish, and had an attack of diarrhoea lasting two days during that time. A careful bacteriological analysis of the faeces failed to demonstrate the presence of any organisms usually associated with epidemic enteritis; I am of the opinion that the attack may have been purely accidental, especially as it lasted such a short time, and the child did not lose more than 4 oz. in weight during the attack.

In conclusion, I am of opinion that dried milk is deserving of further trial during the summer months when epidemic enteritis is so prevalent, especially amongst the poorer classes, and, if prepared as indicated, it is a food which if not absolutely sterile is very nearly so.

Appended is the result of the bacteriological analysis both of the solution of dried milk prepared as directed, and also of a sample of ordinary milk after pasteurization. I would desire to acknowledge my indebtedness to my chief, Dr. Eyre, for his kind supervision; also to my colleagues, Messrs. Leeming and Ryffel, for their kind assistance. As unfortunately one supply of dried milk was sent me in a cask a bacteriological analysis was only possible of sample "B," which was sent out in sealed tins. A solution in sterile water smeared on the surface of nutrose agar failed to give a growth in seventy-two hours after incubation at 37° C.

Bacteriological Analysis of Sample B Dried Milk.

Ten grams were weighed into a sterile flask and made up to 100 c.cm. with sterile water and used for analysis.

Number of organisms growing on gelatine plates and capable of multiplying at 20° C. after six days, 200 per c.cm.

Organisms on agar plates cultivated at 37° C., 0 per c.cm.

"Microbes of indication":

<i>B. coli communis</i>	absent from 1 c.cm.
<i>B. enteritidis</i> (Gaertner) ...	" " "
<i>B. enteritidis sporogenes</i> ...	" " "
<i>Streptococcus faecalis</i> ...	" " "

No tubercle or diphtheria bacilli could be detected.

A few moulds developed on the plates, but were probably only indicative of aerial contamination; 50 c.cm. were centrifugized in a high-speed machine, and both cream and deposit examined microscopically and culturally for organisms, but none were detected. A few leucocytes only were observed in cream and deposit.

A sample of ordinary cow's milk was subjected to pasteurization for twenty minutes at 75° C., and after straining through four thicknesses of sterile butter muslin into a sterile flask, gave the following result on analysis:

Organisms growing on gelatine plates at 20° C., 70,000 per c.cm.
Organisms growing on agar plates at 37° C., 800 per c.cm.

Cream and deposit after centrifugalizing examined microscopically:

Cream:	Streptococci	} present
	Staphylococci	
	Epithelial and pus cells	
Deposit:	Streptococci	} present
	Staphylococci	
	Epithelial and pus cells	

Cultures on blood serum of creams and deposits showed the presence of a large Gram-positive, spore-bearing bacillus, probably *B. subtilis*, only (not inoculated or investigated further).

Specific examination after pasteurization—

<i>B. coli communis</i>	absent from	...	1 c.cm.
Klebs-Loeffler bacillus	"	...	1 "
<i>B. enteritidis</i> (Gaertner)	"	...	1 "

No tubercle or diphtheria bacilli were detected in cream or deposit.

CAN OPSONIC ESTIMATIONS BE RELIED ON IN PRACTICE?

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It frequently happens in hospital practice and in private that a reliable method of diagnosing difficult cases of infection is urgently needed. In no disease is this more true than in tuberculosis. For general use, where ordinary methods fail us, the cutaneous methods of von Pirquet, Moro, and Wolff Eisner, including Calmette's modification of these by conjunctival instillation, are not of pre-eminent value. In private practice the dangers and fallacies of

Chart showing Different Opsonic Indices of Identical Serums, as Estimated by Different Observers.

Calmette's test effectually bar its universal acceptance. Of Professor Courmont's modification of the serum diagnosis of tuberculosis there are not as yet sufficient data to judge. In this country, and in America, it is widely believed that in the opsonic index we have at last a method which is trustworthy not only for diagnostic purposes, but also for prognosis, and in determining treat-

ment. After extensive trial of its merits, mainly in tuberculosis, over a period of three years, I am not able to endorse the view that the index is a safe guide to diagnosis and treatment, even when estimated by acknowledged masters of the opsonic art.

In order to test its value as presented to us to-day, I have from my own private practice taken a series of cases, some of which had been sent for diagnosis, and in whom a trustworthy opinion, apart from physical signs, was therefore of real importance. No sort of selection has been made, and results that favour the opsonic method of estimation have been impartially recorded side by side with the unfavourable ones. In all cases the nature of the test has been explained to the various observers, who have without exception encouraged the inquiry. One observer, indeed, expresses the hope that the tests will be published in order to stimulate further efforts in improving the technical details. Such devotion to the highest traditions of scientific research cannot but command our admiration. Each observer mentioned in the accompanying chart is the same throughout, and is designated always by the same letter. It is, perhaps, unnecessary to say that only experts with years of practice and only those directly connected with well-known laboratories have been asked to examine the various serums supplied. In each of these twelve cases two or more samples of serum drawn at the same time and under precisely similar conditions, have been sent to two or more workers, sometimes in the same laboratory, sometimes in different laboratories. In addition to this, as will be seen, occasionally two samples of the same serum have been sent to one observer, who was not informed that they were samples of identical serums.

In each case the following precautions were taken:

1. Whether taken from vein, finger, or ear, the serum was separated from the clot at the end of six hours after puncture of skin or vein.
2. No serum was estimated unless quite free from contamination from red cells.
3. In sealing the tubes all possibility of heating the serum was obviated by using tubes with long drawn ends.
4. All tubes were sealed within five minutes of collection.
5. All indices were estimated within twenty-four hours of collection.
6. All samples of each batch of serum were taken from blood provided by one bleeding, in most cases by venipuncture.

TESTS 1 AND 2.

Disease suspected: renal tuberculosis.

A dose of 0.005 mg. T.R. tuberculin was administered by the mouth and the indices to tubercle bacillus were estimated by two observers in different laboratories, both before and after inoculation. The interval between the two sets of observations was fifteen hours. The indices returned were:

<i>Before Inoculation.</i>			
Observer A.	O.I. to T.B. ...	1.29	Phagocyte count not kept
Observer T.	"	0.97	"

<i>After Inoculation.</i>			
Observer A.	O.I. to T.B. ...	1.15	Phagocyte count not kept
Observer T.	"	1.30	"

In this case observers A. and T. differed in their estimation of the index after inoculation by 0.15, a small difference. Before inoculation they differed by 0.32, a not inconsiderable difference. Further whilst A. estimated that inoculation was followed by a fall of index, Observer T. registered a rise. Two indices were within normal limits and two outside it.

TESTS 3 AND 4.

Disease suspected: tuberculosis, position of focus unknown. In this case there was no direct evidence of any organ being directly the seat of tuberculous infection, but in view of anomalous pyrexia it was necessary to exclude, if possible, such a contingency. Two series of observations were therefore undertaken with a week's interval. In the first test two samples of the same serum were sent to one observer, and a third sample was sent to a second observer in a different laboratory.

The indices returned in the first test were:

Observer A.	O.I. to T.B. ...	1.34	Phagocyte count not kept
Observer T.	"	0.67	"
Observer T.	"	0.55	"

In the second test three tubes of the same sample of serum were sent to three observers in three laboratories a week after the first test.

The indices returned were:

Observer A.	O.I. to T.B. ...	1.06	Phagocyte count not kept
Observer B.	"	0.98	"
Observer T.	"	0.82	"