EVAPORATED MILK IN INFANT FEEDING

BY

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Attention has recently been drawn to eight large outbreaks of food-poisoning which occurred within one month (Anderson and Stone, 1955; *Monthly Bull. Minist. Hlth*, 1955; *Lancet*, 1956). They were all traced to spray-dried milk and found to be due to a staphylococcal enterotoxin. During the preparation the actual organisms had been destroyed, but the toxin, which is relatively heat-stable, had not. It is destroyed by heating to 88° C. (190.4° F.) for one hour. Roller-dried types of dried milk have not been incriminated in similar outbreaks, but they do contain live micro-organisms which can on occasion give rise to gastro-intestinal upsets. A personal experience, for example, was of an infant who developed diarrhoea after the first feed from a newly opened tin. The laboratory reported "a heavy growth of *B. proteus*." The fact that tins are dated indicates a recognition of some degree of danger.

In evaporated tinned milk we have a perfectly safe infant food. The milk is received from the farm and raised to an initial temperature of 212° F. (100° C.) during solids stabilization and, later during final sterilizing (after cans are hermetically sealed), to 240° F. (115.5° C.) for 15 minutes. During this process no milk is retained in any chamber for more than 15 minutes between the heating processes. This is of considerable significance because investigations have shown that 35% of cases of bovine mastitis are caused by the staphylococcus (Malcolm, 1957). Milk may therefore arrive at a factory already contaminated, although untouched by hand. In the investigations referred to above a steady build-up was found in the staphylococcal count in a balancing chamber which was incompletely emptied during a working day. This could not happen in the process of evaporating milk. The final sterilization completely eliminates any live organisms or spores. There only remains the question of heat-stable toxin remaining potent. The factory process of evaporation does not give any opportunity for a build-up of toxin-producing organisms. It would therefore seem impossible for the end-product to contain any, unless perchance the milk already contained a toxin when it arrived at the factory. The staphylococcal enterotoxin is, of course, peculiar in that although it is inactivated by heating to 65° C. for 30 minutes, it may withstand heating to 100° C. for 15 to 30 minutes (Wilson and Miles, 1955). Milk arrives at the factory from many sources, and any toxin which may be contained in a sample is no doubt so diluted in the bulking process that the chances of its causing any gastro-intestinal upset are extremely remote.

Why, then, is it not more widely used in this country as an infant food? The answer appears to be "that uncritical prejudice has been the chief factor in the limitation of its use." This is a quotation from a paper by Marriot and Schoenthal published with reference to their experience in America as far back as 1929. It seems equally true in this country nearly 30 years later.

Experience in Blackburn

Evaporated milk has been in general use in infant feeding in the Blackburn Group of Hospitals for over four

years. It would appear that experience here can be of use to others, and is therefore worth recording.

In the Blackburn Group, the original intention was not specifically to introduce evaporated milk as the basic food for infants. What was desired was some simplification of the routine in the milk kitchen. It was the policy up to that time to continue to use whatever food the infant had been having up to its admission. Many different feeds were therefore being used. This seemed wasteful in time and in money, as tins of various brands of dried milk inevitably were unused through going "out of date." The question to be settled was therefore what food could be used to eliminate these troubles. It has been repeatedly demonstrated, and is within the experience of most of us, that an infant can thrive on almost any of the recognized branded foods and on the national products. Clearly the decision had to rest on factors other than simple nutritional value. After due thought it was felt that in evaporated milk we had a product with a combination of qualities not found collectively in dried foods. It is quite sterile and does not deteriorate on keeping. It mixes easily and the end-product is homogeneous. There are no large particles and the fat does not separate out. There is no tendency to blockage of the holes in the teat and thus no temptation for the attendant to finger the teat. The fat is very finely divided into globules only one micron in diameter. This aids its digestibility by increasing the surface area exposed to digestive enzymes. The heat treatment modifies the protein physically, with the result that a fine soft curd is formed in contrast to the tough curd of untreated milk. This also is reflected in the stool, which resembles that of a breast-fed infant. The altered protein has less allergenic properties. Finally, evaporated milk can be used for infants of all ages, both mature and premature, and also when cereals are added, if desired. It was therefore decided to adopt evaporated milk for general use in infant feeding in this group of hospitals virtually to the exclusion of all other artificial foods.

It must be stressed that the first choice of feed is always breast milk. This applies not only in the maternity departments of this group but also in the children's general wards. Mothers are admitted with the infant whenever possible for breast-feeding. Expressed breast milk is used whenever it can be procured for appropriate cases.

Preparation of Feeds.—The system known as pre-sterilization is adopted in the milk kitchen. Evaporated milk is eminently suitable for this method. Feeds for 12 or 24 hours are prepared in bulk and the bottles filled, cooled rapidly, and placed in a refrigerator. At feed-time the bottle is placed in a container of hot water and brought to the required temperature.

Premature Infants

It has been repeatedly demonstrated that evaporated milk, suitably modified by dilution with water and the addition of sugar, is as good a feed as any spray-dried, roller-dried, or untreated cows' milk (Ford, 1949; Gruber *et al.*, 1949; Sturrock, 1952). Moncrieff (1956) suggested that perhaps unsweetened evaporated milk is the most practical alternative to breast milk. Sauer (1932) had the opportunity of feeding two triplets on an evaporated-milk formula and comparing them with the third, who was breast-fed. He found that the weight gains were similar, and that frequently the stools could not be distinguished.

A basic formula of one part evaporated milk and two parts water with one level teaspoonful sugar per 4-oz. mixture (3 g. per 100 ml.) of evaporated milk used, serves very well as a feed for premature infants. No rigid quantity per pound is used. It varies widely with different infants. Feeds begin between the second and fifth days of age according to size and condition of the infant. There seems nothing to be gained by using dilute feeds at first. Usually bland fluids are given initially, then a small quantity of full-strength milk formula, and this is increased as rapidly as is practicable up to the amount that experience shows the infant will comfortably

take. This may be 4 oz. or more per pound (250 ml. or more per kg.) body weight per day in some cases. Concentrated vitamins are introduced from the end of the first week and an iron preparation is given by mouth after the first month. Artificially fed infants are usually discharged when they weigh 5½ lb. (2.5 kg.). When expressed breast milk has been available a gradual change over to the milk formula is made when 5 lb. (2.3 kg.) is reached. Usually the mother has by this time considerable experience in caring for her infant, as more often than not she is kept in hospital with the baby. In all cases she is shown the preparation of feeds and the care of teats and bottles. She is given a printed guide to subsequent feeding and is seen from time to time in a follow-up clinic. The local authority is notified in advance of her discharge and she is supervised in the home by health visitors.

It was previously our practice to change from expressed breast milk to a half-cream roller-dried milk. It was often noted that the infants' buttocks quickly became red and not infrequently actually became raw. The sisters from time to time suggested that changing to some other brand of milk would prevent this trouble. The brands were accordingly tried, always with disappointing results. Sore buttocks continued to occur. It was with some surprise that we gradually became aware that when evaporated milk was used there were very few sore buttocks in the premature infants and that when they did occur it was usually as a result of antibiotic therapy and due to thrush infection. This was certainly not one of the findings anticipated when the type of feeding was chosen. The reason for the improved results so far as buttocks are concerned is not very clear. It seems unlikely that sterility is the answer, as a good milk-kitchen technique with terminal sterilization had been employed. It seems likely to be associated with the presentation of the fat, but no special experiments have been done to prove this hypothesis. It is interesting, however, to record Lowenburg (1929), who wrote of evaporated milk: "Complete digestion of the fat is practically assured and the irritating effect of free fatty acids so troublesome with ordinary milk is eliminated."

Another common finding when a change was made from expressed breast milk to a half-cream milk was that the infant put on a great deal of weight very rapidly and became bloated and rather pale. This appearance is not seen when an evaporated milk formula is used. The infants resemble the breast feeders much more closely than when fed with other types of milk.

Full-term Infants in the Maternity Department

Where breast milk cannot be employed all infants are fed with an evaporated milk formula. The same formula as for premature infants can be used. An average infant will take about 2½ to 3 oz. per pound (156–190 ml. per kg.) body weight by the end of the first week. We have had no occasion to use any other feed. Bland fluids are, of course, given for various reasons, but when milk feeds are begun it is evaporated milk which is invariably used in default of breast milk. The mother is given details of how to carry on after discharge and the usual follow-up arrangements are made. No effort is made to influence her choice should she prefer to use some other type of feed. Feeding full-term infants with the evaporated milk formula has proved to be entirely satisfactory and is accepted as such by all concerned in the maternity department. There is no desire to change back to a dried milk. When the method was introduced there was, of course, as much prejudice within the department as elsewhere, but in the light of experience all that has long since disappeared.

Infants in General Wards for Sick Children

Formerly it was our practice to keep the infant on the feed it had been having up to the time of admission. Thus many brands were employed. This meant that a nurse had to spend a lot of time preparing feeds in the milk kitchen and that there was waste on account of tins going out of date. It was to see if these two factors could be eliminated that the question of a standard feed was considered. As

described above, it was decided to give a trial to an evaporated milk formula, and by general consent the trial has extended into accepted routine.

The present practice is to put all infants who are not receiving breast milk on the evaporated milk formula. This is done without regard to the feed used outside hospital. Bland fluids are used as indicated by the medical condition, but when milk is reintroduced into the diet it is the reconstituted evaporated milk which is employed. If a cereal is necessary, it can be added to the formula without any difficulty, just as it can be added to fresh cow's milk. Bottled pasteurized milk is used when the toddler stage is reached.

So far there has been little need for any other milk. Evaporated milk is used for the ordinary run of cases of respiratory infections, feeding difficulties, meningitis, urinary infections, and the like; and also for the more complicated cases, such as coeliac disease, infantile eczema, and other allergic conditions. It has been used in hypercalcaemia and in hyperchloraemic renal acidosis. But there is no fetish in its use. Other feeds have simply not been necessary. In America it seems commonplace for an infant to require a soya-milk feed in treatment of allergy, but we seem to manage quite nicely without it here. Now that calcium-free milks are available we may perhaps get quicker results with the hypercalcaemic infants, and shall certainly use such a milk if necessary. But experience shows that the standard formula used is an excellent general artificial feed and that there is no necessity to stock various types of branded milks. One might anticipate that some other milk could similarly be used quite successfully. We have not put this to the test, as we feel that evaporated milk is essentially safest and is the least trouble to prepare.

If a high-protein feed is required, a more concentrated formula can be prepared by using less water, or protein can be added to the standard formula. Feeds with a lower fat content are very rarely required. This is probably because the fat is so finely divided into globules. Citration is not commonly employed in this unit, but it can easily be done if desired.

In an Isolation Hospital

Isolation hospital units are usually difficult to staff these days; standardization of feeds is therefore especially desirable if it can be achieved. This has proved to be just as possible here as in other departments. Perhaps the most important type of case to consider is that of gastro-enteritis. We follow the usually accepted practice of rehydration, electrolyte balance, and electrolyte repair, and come eventually to the reintroduction of milk feeds. The usual standard formula can again be employed without any difficulty. It is used just as ordinary milk is used in the older child. If the very wasted infant should require high-protein treatment a stronger—less dilute—preparation of evaporated milk is usually well tolerated. A protein preparation can be added to the ordinary formula if desired. Evaporated milk is similarly used in the dysenteric diseases. Lactic acid feeds and the like appear to be quite unnecessary and the results are at least as good as previously.

Evaporated Milk Outside Hospital

There has been no question of "pushing" this type of feeding by doctors and nurses in the hospitals. Its adoption by those in hospitals has had inevitable repercussions outside. Mothers from the maternity departments have continued to use the preparation when they reach home. Other parents have associated the feed given in the hospital with the recovery of their sick child and wish to continue on the feed. Those whose job it is to market evaporated milks have not, of course, been slow to take advantage of the situation thus created. The result is that the milk is now stocked by the welfare clinics, and those concerned with infant feeding are becoming well versed in the use of evaporated milk. Many mothers keep their infants on the formula until the stage of toddler diet and a few even beyond. Others prefer to use some other feed, and from

the hospital end no attempt is made to influence them one way or the other. It is true to say that in this area parents are "getting used" to evaporated milk for infant feeding. The health visitors are also by now quite accustomed to advising on how it should be used.

There are many substandard homes and many ignorant parents in this area. There is a tendency to think that a tin of evaporated milk is dangerous in such circumstances. This is, of course, the reverse of the truth. A baby taking a full bottle uses a whole tin of milk in a day. As both milk and container are sterile there is little danger here. An infant on a 4-oz. (114-ml.) feed uses a tin in two days. Some manufacturers issue a half-size can, which would be used in one day. If the tin is cleaned on top and pierced by two holes and covered with a clean saucer after each portion of milk is withdrawn, there is little likelihood of contamination. If the tin is kept on the mantelpiece over a hot fire, and cleanliness is not a feature of the family, then there may be some risk of contamination, but it is still likely to be much less than if a dried milk is used. There is an appreciable moisture content in so-called dried milk. The tin lasts not one day or two days, but one week or two weeks. It is not sterile to begin with, and the hand of the preparer of the infant feed is put into the package 20 to 40 times each day—say, over 200 times by the time the package is finished. It is not likely to remain uncontaminated.

Some advocate the preparation of a full 24-hours requirement of food at once. This is, of course, quite suitable for hospitals and for the home in which there is a refrigerator. It is satisfactory in winter in any clean home, but in the less clean home it is probably undesirable. Far better to pour the requirement of each feed into the cleansed bottle and add the appropriate amount of boiled water and sugar, and use straightaway. The residue is best kept in the tin. This should be covered and placed in a cool place as indicated above.

A Formula for General Use

Experience shows that one great and common difficulty besets all who would advise on the use of evaporated milk for feeding of infants. How do we carry in our head the data on which to base a formula for any given child? Most doctors and nurses carry in their heads relevant facts on which they can check feeds if a dried-milk preparation is used. This is usually based on a fluid requirement of 2½ oz. per lb. (156 ml. per kg.) of body weight per 24 hours. If the feed is four-hourly and five feeds are given in a day, then half the expected weight in pounds gives the size of the individual feed—namely, a 10-lb. (4.5-kg.) infant requires about five feeds of 5 oz. (140 ml.) each. This can easily be applied to the evaporated milk if the following formula is used:

Evaporated milk, one-third	} This provides about 20 calories per oz. (28 ml.)
Water, two-thirds	
Sugar, a level teaspoonful for every 4 oz. (114 ml.) of the mixture ..	

Thus a 12-lb. (5.4-kg.) baby would require approximately a 6-oz. (170-ml.) feed five times a day. The formula is:

		Calories	
Evaporated milk ..	2 oz. (57 ml.) ..	100	} 122½
Water ..	4 oz. (114 ml.) ..		
Sugar ..	1½ teaspoonfuls ..	22½	
Per day ..	30 oz. (850 ml.) ..	612	

This is an approximation, and many infants will take nearer 3 oz. per lb. (190 ml. per kg.) of body weight. It will be seen that this formula conforms to accepted standards of daily calorific requirement. It is sometimes desirable to give some extra water. This can be given as plain water or as a separate drink containing a vitamin-C preparation.

As with dried foods, some evaporated milk is fortified with vitamin D. It is unwise to rely on this alone to substitute for cod-liver oil, as there is then a deficiency of vitamin A. Sturrock (1952) found that infants so fed had significantly more upper respiratory infections than those fed on other milks and supplemented with additional vitamins in the form of cod-liver oil or vitamin concentrates.

Cod-liver oil or its equivalent plus orange juice or its equivalent should always be given.

In this country evaporated milk contains 33 I.U. of vitamin D₃ per undiluted fluid ounce (28 ml.). This means that when reconstituted there are about 500 I.U. per quart (440 I.U. per litre). National dried milk contains 1,400 I.U. per reconstituted quart (1,230 I.U. per litre) and an average figure for other proprietary powdered milks is 1,600 I.U. per reconstituted quart (1,410 I.U. per litre). In view of the suspicion that idiopathic hypercalcaemia of infancy is associated with a high intake of vitamin D, it will be noted that if evaporated milk is used the additional vitamin A can be given without unduly raising the vitamin-D intake—for example, a teaspoonful of cod-liver-oil compound as issued by the infant and child welfare clinics contains about 700 units of vitamin D and 3,500 units of vitamin A, and if given to supplement a daily intake of 20 oz. (570 ml.) of evaporated milk formula, means a total daily intake of about 950 units of vitamin D plus an additional 3,500 units vitamin A. If, on the other hand, 20 oz. (570 ml.) of reconstituted dried milk were given plus a teaspoonful of cod-liver-oil compound, 1,400 to 1,500 units of vitamin D would be taken daily plus the additional 3,500 units of vitamin A.

Cost as Compared with National Dried Milk

The cost of an ounce (28 ml.) of reconstituted evaporated milk is 0.4 pence and of reconstituted National dried milk 0.245 pence. It would seem on first sight, therefore, that it would cost nearly twice as much to feed an infant on evaporated milk as on National dried milk. This, of course, is far from the truth. The Table shows the relative cost to

	4 oz. (114 ml.) National Dried Milk × 5	4 oz. (114 ml.) Evaporated Milk × 5	8 oz. (227 ml.) National Dried Milk × 5	8 oz. (227 ml.) Evaporated Milk × 5
Baby food per day	4-9d.	8-0d.	9-8d.	16-0d.
Fresh milk, 1 pint	8-0d.	4-0d.	8-0d.	4-0d.
Total cost per day	12-9d.	12-0d.	17-8d.	20-0d.

a family which uses 1 pint (570 ml.) of fresh milk and, for the baby, either National dried milk or evaporated milk, bearing in mind that one cannot have both National dried milk and priority cheap milk for the same infant. While baby is small it is cheaper to feed on evaporated milk than on National dried milk, while when he is big it is more expensive. It is clear that the difference in cost is negligible. It is to be noted that no specific formula is being used here, both milks being merely reconstituted to cow's milk standard for fair price comparison.

Summary

Evaporated milk can be used as an infant feed for premature and mature infants in maternity departments where breast milk cannot be used. It can be used as a feed for infants in wards for sick infants, including wards for infectious diseases. It can be used, with very rare exceptions, to the exclusion of all other milk preparations if desired. A simple method of calculating feeds based on the 2½ oz. fluid per pound (156 ml. per kg.) per day is described. This enables doctors and nurses to prescribe the appropriate feeds as easily as for any other food. It is shown that it makes very little difference to a family budget whether evaporated milk or National dried milk is used.

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