Fat content of expressed breast milk: a case for quality control

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Abstract

Expressed breast milk used to feed preterm infants is precious and so, despite heterogeneity of composition, all available milk is used. A study of 274 samples of expressed breast milk supplied by preterm mothers and National Childbirth Trust donors showed pronounced variation in fat content as measured by the "creamatocrit" method. This was not due to differences between term and preterm mothers or between transitional and mature milk. The composition was affected by diurnal variation and method of collection. Substantial amounts of fat were also wasted as a result of continuous nasogastric feeding. Several milk samples did not contain enough fat to supply even a fraction of the recommended energy requirements of these infants.

Some type of quality control over samples of expressed breast milk is clearly essential. The creamatocrit method is simple and feasible.

Introduction

The suitability of breast milk for preterm infants is controversial.[1] Some workers have shown interest in new artificial formulas designed to satisfy the growth and energy requirements of preterm infants,[2] while those who believe that the unique biological properties of human milk are important have devised systems for collecting and storing this product. Breast milk may be used raw or after heat treatment and with or without bacterial surveillance.[3] Pooled milk may be used to avoid heterogeneity of chemical composition,[4] but individual samples may be preferred,[5] particularly if from the child's own mother.[6] Although the method of collection influences the fat content of breast milk,[7] because it is so precious all available milk is normally used. In the Nottingham City Hospital neonatal unit individual samples from preterm mothers and National Childbirth Trust donors are fed raw to preterm infants. Casual observation of the milk in giving sets shows that the content of the milk varies widely. Some milk samples are thick, creamy yellow, while others are thin and white. We have therefore measured the variation in fat concentration and hence energy value of this milk.

Patients and methods

All milk examined was supplied to the Nottingham City Hospital neonatal unit for feeding to preterm infants.

Breast milk donation—Breast milk expressed by hand or with a manual breast pump was donated by mothers of preterm infants to feed their own babies. Spare milk was given to other preterm infants. Extra milk was obtained from healthy donors breast feeding their own full-term infants at home. These donors collected milk in several ways—namely, they expressed either before or after feeding their own infant or from the opposite breast to the one that had been milked. Only one donor collected a mixture of drip and expressed milk, and as the results in these samples did not differ from the group as a whole they were included in the general analysis. Milk was stored in glass or plastic bottles at 4°C for up to 24 hours.

Samples—All stored samples were examined once or twice a day. The bottles were well shaken and a sample drawn into a standard heparinised glass capillary tube. Foremilk and hindmilk were compared in six mothers by obtaining capillary samples from the first and last 10 ml of milk expressed from one breast. Two methods of continuous nasogastric feeding of expressed breast milk were simulated, one controlled by an IVAC infusion pump and the other by a syringe pump positioned vertically. Capillary samples were obtained before and after the milk had been dispensed to determine how much fat had been lost in the apparatus. This was repeated six times for each method. Fat concentrations were measured by the "creamatocrit" method of Lucas *et al.*[8] The fat layer, including liquid fat when present, was measured with an ordinary plastic ruler, which gave a measurement accurate to the nearest 0·5 mm. The end of the tube was sealed with Plasticine.

Calculations and statistics—The creamatocrit was expressed as a percentage of the total milk sample in the tube to the nearest 0·5%. Milk fat was calculated from the creamatocrit by the formula, fat (g/l) = (creamatocrit (%) − 0·59)/0·146, and energy content by the formula, kcal/l = 290 + (68·8 × creamatocrit (%)).[8] Statistical significance was tested with Student's *t* test.

Results

A total of 274 samples were analysed from 21 mothers (those feeding their own preterm infants) and 10 donors (those feeding their own full-term infants at home). The mean creamatocrit was 5·2% (31·5 g/l) for the whole group (table I) and for both donors and mothers when analysed separately. The range was 0·5-13%. The large variation was present both between donors and in samples from just one woman (table II). Transitional milk produced three to 10 days after parturition did not differ from mature milk produced from the 11th day: mean creamatocrit was 5·3 ± SD 2·3% for 69 samples of transitional milk and 5·2 ± 2·4% for 200 samples of mature milk. On 29 occasions in 13 mothers we compared two samples obtained during the same morning, between midnight and midday. There was a highly significant difference in fat concentration between the first and second samples, the first sample containing much

TABLE II—*Distribution of creamatocrit values in 27 samples of expressed breast milk donated by a single mother*

Creamatocrit (%)	2·1-	3·1-	4·1-	5·1-	6·1-	7·1-8
No of samples	2	2	4	7	9	3

TABLE I—*Distribution of creamatocrit values in 274 samples of expressed milk*

Creamatocrit (%)	⩽1	1·1-	2·1-	3·1-	4·1-	5·1-	6·1-	7·1-	8·1-	9·1-	10·1-	11·1-	12·1-13·0
No of samples	2	23	37	42	48	41	36	14	15	7	3	2	4

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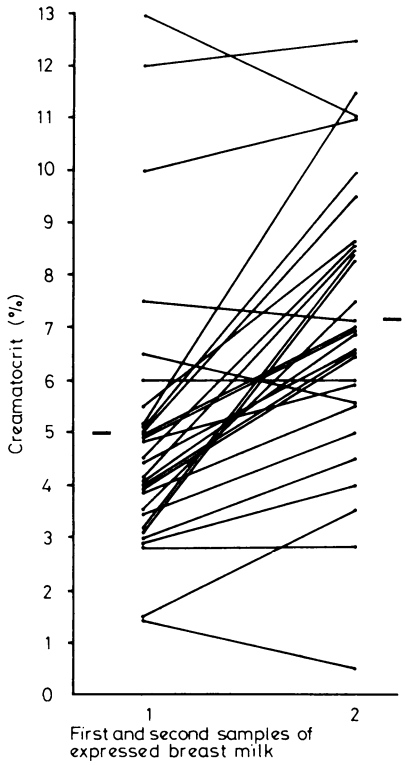
less fat than the second ($t-5{\cdot}23$; $p<0{\cdot}001$) (figure). Similarly the foremilk invariably contained less fat than the hindmilk. The mean difference was 38%.

A mean of 34% of the fat in expressed breast milk was lost when using the IVAC infusion pump and a mean of 19% lost when using the syringe pump.



Creamatocrit values in first and second samples of milk expressed during same morning (mean values).

Discussion

A survey of human drip milk supplied by donors to the milk bank at Leicester Royal Infirmary[9] showed great variability in fat concentrations, the mean value being only 17 g/l. We also found considerable variation in individual samples of expressed breast milk, although the mean value was higher (31·5 g/l). This variation was not due to differences between preterm and term mothers or differences between transitional and mature milk. Hytten[7] found that some women are low-fat secretors; he also described a diurnal variation in fat content, the early-morning specimen containing much less fat. We confirmed this diurnal variation as one of the factors in the variations in the creamatocrit of expressed breast milk.

Differing methods of collection also increase variability, as some favour foremilk and others hindmilk. A sucking baby determines its own milk intake to some extent, whereas the preterm infant is not only restricted to the volume it is given but also may be fed on one low-fat sample for a full 24 hours. Furthermore, we have shown that substantial amounts of fat are wasted when drip sets controlled by an IVAC infusion pump are used for continuous feeding. Smaller though still appreciable amounts are lost when using a vertically placed syringe pump. Some at-risk babies therefore receive milk with a much lower energy content than the recommended 100-150 kcal/kg (1000 kcal ≈ 4·2 MJ). One solution is to use pooled breast milk, but this negates the immunological benefits of using an infant's mother's own milk and requires careful bacterial surveillance: it also requires a banking system, which would be beyond the scope of many small units. The creamatocrit method is a simple and feasible way of exercising quality control over expressed breast milk samples. Altering the technique of collection would ensure that fewer substandard specimens are supplied. Milk with a creamatocrit of 4% has an energy content of only 560 kcals/l. It seems prudent to discard samples with a lower energy content than this.

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ONE HUNDRED YEARS AGO M Charcot, it is well known, has done more towards the elucidation of the cataleptic and allied states, than any living investigator. In a recent lecture, communicated to the *Progrès Médical* by G Ballet, he distinguishes and describes two such conditions, which he calls respectively "Hysterical Lethargy," and the "Cataleptic State." Most cases of typical "grave hysteria" can be thrown into the first of these two conditions by directing the eyes to be fixed steadily on some point, the tip of a penholder held in the hand, for instance: in a few moments, "the head inclines to the right, or to the left; the eyelids close"; the limbs become motionless and limp; but the power of speaking remains. The patient can answer questions, can count, and even calculate; can recite any verses which she may happen to know by heart, and can write from dictation. This is the condition of hysterical lethargy. If, now, the eyelids of a patient in this condition be raised, and the retinae thus stimulated by light, she immediately becomes cataleptic; the limbs, no longer limp, remain in any position in which they may be placed; and the power of speaking is completely lost. M Lepine first performed a most curious experiment on one of these women; and his observation has since frequently received full confirmation. He found that, by raising the eyelid on one side only in a patient in hysterical lethargy, he could throw the corresponding half only of the brain into a condition of catalepsy. If the left eye only were opened, the left side only became rigid, and *vice versa*. But there was this remarkable difference between the two sides, that whereas opening of the left eye in nowise interfered with power of speech, opening of the right immediately destroyed it. For instance, a woman in the lethargic state was caused to repeat some verses; the left eye was opened, she continued her recitation; it was then closed, and the right eye opened instead; straightway she ceased to speak; on again closing the right eye, she began her verses again at the very place she left off, recommencing sometimes in the middle of a word. This experiment clearly points to the conclusion, long since arrived at on other grounds, that the faculty of speech has its local habitation in the right half of the cerebrum. (*British Medical Journal*, 1881.)