ORIGINAL ARTICLE

Breastmilk Feeding Status and Weight Gain of Low Birth Weight Infants in a Neonatal Intensive Care Unit

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Summary

A prospective observational study of feeding in low birth weight (LBW) infants with birth weight (BW) of at least 1.8 kg admitted to the Neonatal Intensive Care Unit (NICU) showed that nearly 80% of mothers provided expressed breastmilk (EBM) and a further 14% breastfed their infants before discharge. Weight gain was overall poor at a mean of 9.48 +/- 7.82 grams per kg per day with those on predominant EBM feeding (EBM >70%) doing worse than those on predominant preterm formula (PTF) feeding (EBM < 31%), weight gain being 5.40 +/- 6.88 and 11.10 +/- 8.15 grams per kg per day respectively ($p < 0.01$). Weight gain was also poorer (7.72 +/- 5.55 grams per kg per day) in patients with respiratory distress syndrome (RDS) compared to those who did not have RDS (12.02 +/- 9.58 grams per kg per day). $p<0.05$. Incidence of infants <10th centile body weight at birth was 16.8% and at discharge was 69.1%.

Key Words: Expressed breastmilk; Preterm formula; Weight gain; Growth-retardation

Introduction

The importance of breastmilk especially for preterm infants has been well recognised and EBM has been associated with a reduction of necrotising enterocolitis (NEC)[1] and a higher developmental score in preterm infants on subsequent follow-up[2] compared to a standard formula. However, it has been recognised that breast milk may not be appropriate for LBW infants who are born before the large deposition of nutrients takes place during the final trimester of gestation as the amounts of many nutrients which could be delivered in reasonable volumes of breast milk are not adequate or equal to that deposited at the intrauterine rate. In an endeavour to provide sufficient nutrition and at the same time to confer the hormonal and immunological benefits of breastmilk to this group of vulnerable infants it is the policy of many NICUs to feed preterm infants expressed breastmilk that has been fortified with additional nutrients. Fortifying preterm milk with protein has been shown to improve the gain in weight, length and head circumference of LBW infants and studies also support the need for calcium and phosphorus supplementation in preterm infants fed human milk. Preparations of human milk fortifier (HMF) providing extra protein, fat, carbohydrate, vitamins and minerals are currently available for use.

Specialised formulae for LBW infant feeding provide an alternative to fortified EBM in terms of nutritional needs. Recommendations specific for LBW infants were formulated by the Committee on Nutrition of the European Society for Paediatric Gastroenterology and Nutrition (ESPGAN) in 1987[3] and subsequently amended and modified a few times the latest, being in 1999[4].

Neonatal Intensive Care Units in Malaysia have been using LBW formulae or PTF for many years but more efforts are also being made in NICUs presently to obtain mothers' own milk for feeding in view of the compelling evidence of the superiority of breastmilk and breastfeeding.

Objective

This paper proposed to study the extent of breastmilk feeding in LBW infants as practised in an NICU and the rate of growth in terms of weight gain and differences if any in these infants who are fed with varying amounts of breastmilk.

Materials and Methods

This was a prospective observational study of patients admitted to the Maternity Neonatal Intensive Care Unit (MNICU) with a birth weight of 1800 grams and below admitted and discharged within a period of five months from May 1999 to September 1999. Infants of larger birth weight without any medical complications were not admitted to the NICU and hence not included in the study. Infants with serious congenital anomalies and infants who did not survive on discharge were also excluded. Infants with surgical conditions but remained within the medical unit were included. It was decided that a sample size of about 100 (preferably about 30 in each group) would be adequate for statistical power and hence only the first 100 data records would be analysed.

It was the policy of the unit to feed breastmilk as a priority and gavage feeding with EBM which is mother's own milk (which may be expressed either manually or with a pump) and used fresh or after storage at 4-8°C for not more than 48 hours) was given to those infants who were not yet able to suck effectively (generally infants with BW < 1.5 kg and gestation < 32 weeks and those who were ill). A HMF will be added to the EBM in the ward once at least 25 mls of EBM was obtained on each expression . It was assumed that low milk production occurs in the early days of lactation and preterm mother's milk is already nutritionally adequate during this early period. Besides postponement of fortification in the early days of lactation would allow provision of 'wholesome breastmilk' keeping undiluted its antimicrobial, antibody and other antiinfective properties, factors which are crucial for the LBW infants' immediate survival.

(A sachet of Wyeth HMF used in this study provided fortification to 50 ml of EBM). When breastmilk was not available or inadequate, feeding would be substituted or supplemented with a preterm formula (Dumex Premature Formula was used in this study).

Formula milk was prepared centrally in the hospital Milk Kitchen. The volume of milk feeds given was independent of the type of milk feeds and was decided each day by the ward doctors. In infants where enteral feeding was contraindicated or insufficient parenteral nutrition would be considered. Nurses in charge of each infant were responsible for recording the type and amount of feeding received and also the amount of aspirate obtained at each tube feeding. Volumes were measured by syringes. Infants' weights were measured on a Seca weighing scale Model 727 daily once they were stable. Total volume of milk for each day was summed up and the final total volume of milk received was a cumulative of the daily volumes over the whole stay. Quantitation of volume of aspirate was also similarly done.

For calculating the weight gain per kg per day of each infant, the equation below was used:

$$\text{Weight gain per kg per day} = \frac{\text{Discharge weight (DW)- Birth weight(BW) in grams}}{\text{Length of stay (LOS) - 10 days}} \text{ divided by } 1/2(\text{DW} + \text{BW}) \text{ in kg}$$

The time taken for infants to regain its birth weight and achieve a steady weight gain is dependent on the birth weight and gestation and amount of nutrition taken. The expected time to regain birth weight for babies in this birth weight region was taken at 10 days[5]. The mid -weight between birth weight and discharge weight was

Table I
Dermographic data

Parameters (Overall)	Group A 100-71% EBM (N=18)	Group B 70-31% EBM (N=17)	Group C 30-0% EBM (N=64)	p value for comparison between groups
Mean gestation +/- SD 31.8+/-2.4 wks	31.3 +/- 1.8 wks	31.1+/- 2.9 wks	32.1+/-2.4 wks	>0.05
Mean BW +/- SD 1459+/- 260g	1538+/-209g	1397+/-248g	1453+/-274g	>0.05
Male:Female (49:50)	7:11	9:8	34:30	>0.05
RDS (incidence) 56.3%	72.2 %	64.7 %	49.2%	>0.05
Mean DW +/- SD 1792+/-126g	1787+/-99	1789+/-80	1805+/-142	>0.05
Discharge gestation 36.5 +/- 2.4 wks	36.3 +/- 2.4 wks	36.6 +/- 2.6 wks	36.6 +/- 2.4 wks	>0.05
Mean LOS +/- SD 33.2+/-16.8 d	34.9 +/-19.8 d	38.4+/-16.2 d	31.4+/-16.0	>0.05

Table II
Mean weight gain in grams per kg per day

	Overall (N=96)	Group A 100-71 % EBM (N=18)	Group B 70-31 % EBM (N=17)	Group C 30-0 % EBM (N=61)*
RDS (p<0.02 for Group C vs Groups A&B)	7.72+/-5.55	3.59+/-6.42	8.74+/-4.26	9.13+/-4.71
No RDS (p>0.1 for Group C vs Groups A&B)	11.62+/-9.58	10.09+/-6.24	9.59+/-7.92	11.94+/-10.36
Combined (p<0.01 for Group C vs Groups A&B)	9.48+/-7.82	5.40+/-6.88	9.04 +/- 5.58	11.10+/-8.15

**3 babies were discharged within 10 days and hence excluded from the weight gain calculation*

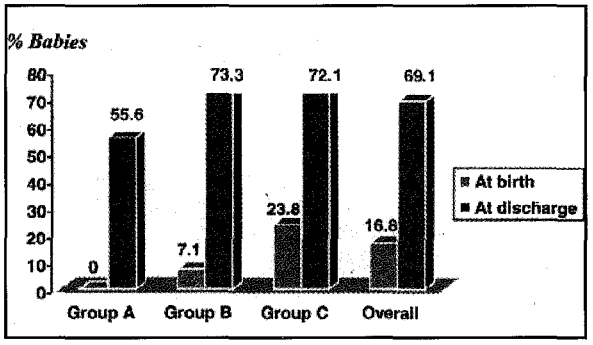
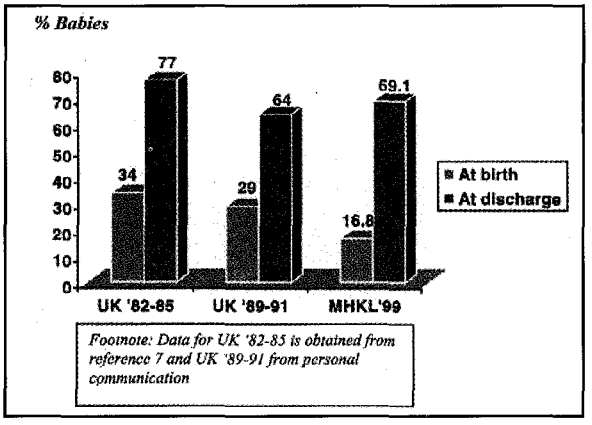


Fig 1 : Percentage of Babies at <10th Centile for Body Weight at Birth and Discharge (comparison between groups)



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used as this calculation was easier to perform than calculation of mean weight gain of each infant per kg for each day of stay which would necessitate daily weights to be available. Many infants were not weighed daily for many days when they were unstable. Weight gain/loss of infants who were discharged before 10 days of age was excluded from this calculation.

The infants are divided into 3 groups for purpose of analysis.

Group A infants had 71-100% of feeds from EBM
Group B infants had 31-70 % of feeds from EBM
Group C infants had 0-30% of feeds from EBM

Other information gathered included demographic information like sex, gestation presence of respiratory distress syndrome (RDS) and data collected was entered into an Excel Database and results were analysed by Student's t test, chi-square test and correlation coefficient.

Results

Prevalence of breastmilk feeding

There was a total of 286 infants of 1.8 kg and below admitted during this 5 month out of which 33 died. The first 106 data sheets of patients discharged were studied out of which 7 had to be discarded because of incomplete data leaving a total of 99 infants for analysis. There were 18 infants in Group A, 17 in Group B and 64 in Group C. In the last group 20 in fact did not have EBM at all but 14 were given breastfeeding when mothers roomed in just before discharge. Therefore 93 (94%) of the LBW infants in the NICU had breastmilk during their hospital stay, thus reflecting the seriousness and efforts of the NICU staff in supporting mothers to provide breastmilk or breastfeeding.

Incidence of growth retardation(<10th centile body weight)

The mean gestation of the whole study population was 31.8 +/- 2.4 weeks and the mean birth weight was 1459 +/- 260 grams with no significant differences between the groups. (Table I) On admission 16 infants (16.8%) were growth retarded and on discharge 65(69.1%) became growth retarded. (Fig.1) Discharge weight and gestation and duration of hospital stay were each not significantly different between the groups and 3 infants in Group C were discharged before 10 days of age and were excluded from the weight gain calculation.

Mean weight gain

A mean weight gain of 9.48 +/-7.8 grams per kg per day was recorded for the whole study population with the infants in Group C having a significantly higher rate of growth (11.37 +/-8.15 g) compared to the other two groups (9.04+/-5.58 for Group B and 5.40+/-6.88 for group A) $p<0.01$. Infants with no RDS grew better than those who had RDS and this was evident in all the groups. The mean weight gain was significantly higher in Group C compared to Groups A and B among the

RDS infants but the higher growth in Group C for non-RDS infants was not statistically different from Groups A and B. (Table II) Correlation between mean weight gain and percentage of EBM feeds was -0.4 for RDS infants and -0.2 for non-RDS infants.

Feed tolerance and incidence of septicaemia

Both EBM and formula were well tolerated and overall volume of milk aspirate was slightly higher for EBM feeds (mean of 1.4+/-2.6% of total volume) compared to formula feeds (0.8+/- 1.8%) $p>0.05$. EBM tolerance was least in predominantly formula fed (EBM aspirate of 2.0 +/- 3.3% in Group C vs 0.5 +/- 1.0 % in Group A) $p<0.01$, and formula tolerance least in predominantly EBM fed babies (formula aspirate of 1.9 +/- 3.7 in Group A vs 0.6 +/- 0.8 % in group C) $p>0.05$. There were 2 cases of necrotising enterocolitis (NEC) in each group accounting for an overall NEC rate of 6.0 %, 2 cases of confirmed septicaemia each in Groups A (11.1%) and B (11.8%), and 3 in Group C (4.7%).

Discussion

Weight gain among the LBW infants in the NICU was poor when compared to the intrauterine accretion rate of about 15 grams per kg per day during the third trimester[6]. The SGA rate was quite low (16.8%) on admission but it can be seen that many more infants (69%) became growth retarded on discharge. The increase in the growth retardation rate was particularly marked in Group A and B infants. (Figure 1). The overall result is consistent with findings by Lucas et al who reiterated that even in the 90s, NICUs in UK have not found a solution to optimum nutrition among the low birth weight infants and a cohort study in 1982-1985[7] showed that 34% of LBW infants (BW<1850g) admitted to 5 NICUs were SGA at birth and 77% were growth retarded on discharge and a repeat study in 1989-1991 showed figures of 29% and 64% respectively. (Figure 2). There were many factors likely to be contributory to poor weight gain in our NICU one of which was the inadequacy of parenteral nutrition support in infants who were ill and not able to tolerate enteral feeds well. There were limitations to the administration of parenteral nutrition on the unit and these included a quota on the production capacity of the pharmacy, the difficulty of venous access and the often poor staffing situation in the NICU.

Fortified breast milk should result in growth effects comparable to commercial preterm formulas[8,9]. The poorer weight gain among those who were fed on a larger proportion of breastmilk in this study could partly be attributed to inadequate fortification. It is suspected that fortification could have been inadvertently missed out or the amount of each aliquot of EBM obtained was often less than 25ml. It is also known that foremilk contains less fat and hence calories than hind milk and small amounts of milk obtained in expression is likely to be drip or foremilk. It is uncertain if other factors like diet and nutritional status of the mothers could also have influence the nutrient content of breastmilk.

It is commendable that 94% of the LBW infants in the ward had been given breastmilk before discharge despite the difficulty of getting mothers to room in. Besides limited rooming-in facilities mothers often had to be at home with other young children, and hospital and community support to obtain EBM from homes were non-existent. The amount obtained from most infants however was low (65% <30% of total feeds) and it would be worthwhile to study how many of these LBW infants were breastfeeding after discharge. Studies comparing standard infant formula and breastmilk have shown some superiority of breastmilk in subsequent neurodevelopment of preterm[2] and term infants[10]. Similar studies comparing preterm formula and breastmilk have not shown advantage of one over the other at developmental assessment at 18 months of age,[11] but it would appear that long chain omega ^{3} and omega ^{6} fatty acids, hormonal growth factors and other unidentified factors in breastmilk would be advantageous for brain development. There is a concern however that inadequate nutrition in the early weeks and months of an infant's life may be associated with subsequent long term adult -onset diseases including diabetes and hypertension[12,13]. Length and head circumference which are other important aspects of nutrition and growth were initially meant to be studied but data was not analysed because of incomplete documentation.

Being an observational study and with small sample sizes obtained in Groups A and B comparison between groups must be taken with caution. Nevertheless weight gain appeared to be negatively correlated with the

proportion of feeding by EBM and this was particularly so among babies with RDS. Even though the coefficients of correlation at -0.2 and -0.4 are not statistically significant a PTF would seem more efficient than EBM for weight gain. Mother's milk is certainly desirable especially for its anti-infective role in the sick vulnerable preterm infants but more studies on the role and ideal way of fortification and use of a PTF in the absence of breastmilk are needed to better understand how to achieve optimum nutrition to ensure a healthy early growth, a favourable neuro-developmental outcome and also possibly, prevention of long term adult-onset diseases .

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References

1. Lucas A, Cole TJ. Breast milk and necrotising enterocolitis. Lancet 1990; 336: 1519-23.
2. Lucas A, Morley R, Cole TJ, et al. Early diet in preterm babies and developmental status at 18 months. Lancet 1990; 335: 1477-81.
3. ESPGAN Committee on Nutrition of the Preterm Infant: Nutrition and feeding of preterm infants . Acta Paediatr Scand 1987; 336 (Suppl): 1-14.
4. EU Guidelines on Low Birth Formulae. Official Journal of the European Community, 7.4.1999, L 9: 29-36.
5. Wilson CW, Cairns P, Halliday HL, et. al. Randomised controlled trial of an aggressive nutitional regimen in sick very low birthweight infants. Arch Dis Child 1997; 77: F4-11.
6. Hay WW Jr. Nutritional requirements of the extremely low-birth-weight infant. In: Hay WW JR, ed. Neonatal nutrition and metabolism. St. Louis ; Mosby Year Book, 1991; 361-91.
7. Lucas A, Gore SM, Cole TJ, et. al. A multicenter trial on feeding low birthweight infants. Effect of diet on early growth. Arch Dis Child 1984; 59: 722-30.
8. Ehrenkranz RA, Gettner PA, Nelli CM. Nutrient balance studies in premature infants fed premature formula or fortified preterm human milk. J Pediatr Gastroenterol Nutr 1989; 8: 58-67.
9. Raschko PK, Hiller JL, Benda GI, Buist NR, Wilcox K, Reynolds JW. Nutritional balance studies of VLBW infants fed their own mothers' milk fortified with a liquid human milk fortifier. J Pediatr Gastroenterol Nutr 1989; 9: 212-8.
10. Lanting CI, Fidler V, Huisman M, et. al. Neurological differences between 9 year old children fed breastmilk or formula as babies. Lancet 1994; 334: 1319-22.
11. Lucas A, Morley R, Cole TJ, Gore SM. A randomised multicentre study of human milk vs formula and later development in preterm infants. Arch Dis Child 1994; 70: F141-6.
12. Barker DJP. Fetal growth and adult disease. Br J Obstet Gynaecol 1992; 99: 275-6.
13. Lucas A. Role of nutritional programming in determining adult morbidity. Arch Dis Child 1994; 71(4): 288-90.