Insufficient early weight gain in preterm babies and influence on weight at 12 months

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SUMMARY Relations between the amount and duration of insufficient early gain in weight and later catch up and absolute weight at 1 year of corrected age were investigated in 30 preterm babies of greater than 32 weeks' gestation. There were no significant correlations to suggest that insufficient early weight gain affected later patterns of weight despite individual weights at 1 year generally being distributed in lower centile channels. These findings have important clinical implications for the feeding of preterm babies.

Preterm babies, especially those born before about 32 weeks' gestation, usually take several weeks to resume gaining weight at a rate similar to that of the fetus at an equivalent gestational age, which is a widely adopted, but not proved, standard against which the adequacy of preterm infants' postnatal gain in weight can be measured.¹ This period of slow early weight gain is a marker of inadequate nutrition, and concern is expressed about its importance to the long term outcome of physical growth and neuropsychological development. Such anxieties, based largely and often uncritically on studies in laboratory animals,^{2–4} have had over the past 10–15 years considerable influence on research and clinical practice to improve the early nutrition of preterm babies. Irrecoverable harm may be caused by the vulnerability of growing organs and tissues to insults on growth at this early stage of development.^{2–4}

We were concerned with physical size and more specifically gain in weight as this measure, with all its imperfections as a specific measure of growth, is the most widely used in clinical practice to judge the overall state of nutritional well being and physical development in young infants and children. We attempted to find out whether the slow weight gain in preterm infants during the first few weeks after birth influences the later pattern of weight gain. Published results vary: some suggest that the early deficit in weight is made up,^{5,6} and others describe a permanent deficit in weight.^{7–9} Generally, these conclusions were reached using absolute size as a measure of the fulfilment of potential weight instead of looking more at measures of weight gain performance. It is impossible to know the true potential size

of any individual baby as so many factors may influence this achievement. In this study we adopt a different approach, investigating the relations that exist between the extent and duration of slow early weight gain and subsequent catch up and absolute weight at the age of 1 year.

Subjects and methods

Thirty preterm white infants of appropriate weight for gestation (greater than fifth centile after allowing for maternal height, birth order, and sex)¹⁰ born before 32 complete weeks of gestation were studied. Mean birthweight was 1340 g (range 900–1475) and gestation, by dates and complemented where needed by the Dubowitz score,¹¹ 30 weeks (range 27–32). There were 14 boys and 16 girls. The babies represented consecutively born surviving babies in this category who were born at the Leicester Royal Infirmary Maternity Hospital in 1980 and 1981, cared for at the neonatal unit, and on follow up had no major health or neurodevelopmental problem that might have influenced weight gain. Twelve babies had an uneventful neonatal course, 16 developed surfactant deficient lung disease (nine required continuous positive airways pressure and seven intermittent positive pressure ventilation), and three suffered neonatal apnoea treated with intravenous aminophylline.

Throughout their stay in hospital, and in accord with practices at the neonatal unit, the babies were weighed twice weekly on scales accurate to 5 g. The general feeding policy during the study period was for babies who were able to be fed enterally yet

unable to have their mothers' milk to be given bank breast milk by drip until a few days before discharge when they were given a milk formula. Babies whose condition precluded milk feedings were initially given a 10% dextrose electrolyte solution followed, if needed, after about five days by a protein hydrolysate (Vamin) and a fat emulsion (Intralipid). The time of discharge from hospital was dictated by general progress, using criteria described previously.¹² The babies were then seen at a neonatal follow up clinic. The first visit was about one week after discharge; the second was as near as possible to the expected date of delivery. Thereafter visits to the clinic were at monthly intervals for three months and then three monthly for nine months (until about 12 months after the expected date of delivery). On each occasion and as part of their overall clinical assessment the babies were weighed, without clothes, on the same type of scales as used in hospital.

Evaluation of changes in weight. Four components of the profiles of weight were determined for each baby:

Insufficient early weight gain

To make a quantitative assessment of insufficient

early weight gain a reference had to be established. Following conventional practices we used intrauterine weight gain as the reference, but only from 28 to 34 weeks' gestational age. The curve was derived from multiple source data compiled by Gruenwald from intrauterine standards of six European and North American populations.¹³ Beyond 34 weeks' gestation we considered it inappropriate to continue to use intrauterine weight gain as a reference as prenatal growth decreases towards the end of gestation. At this developmental stage weight gain of many preterm babies begins to 'take off', therefore, comparisons with the end of gestation are inappropriate. The average value for intrauterine weight gain before late gestation deceleration is similar to the average weight gain shown by healthy babies for the first few months after regaining birthweight.¹⁴ From 35 to 40 weeks' gestation therefore we decided to simply continue the reference curve at the same rate of weight gain.

From the individual weights obtained for each baby a curve was constructed, smoothed, and charted against the reference curve (Figure). The period of insufficient early weight gain was judged to last until the curve ran parallel to the reference curve or shifted upwards. This point was termed the position of maximum insufficient early weight gain.

Figure Scheme for determining amount of insufficient early weight gain and later catch up in preterm baby aged 28 weeks. W_1 =reference weight at birth; W_2 =actual weight at birth; W_3 =reference weight at point of maximum insufficient early weight gain; W_4 =actual weight at point of maximum insufficient early weight gain; W_5 =actual weight at about 1 year corrected age; W_6 =reference weight at about 1 year corrected age.

The following formula was used to estimate insufficient early weight gain; $((\text{birthweight/weight of reference at birth}) - (\text{weight at maximum insufficient early weight gain/weight of reference at maximum insufficient early weight gain})) \times 100$.

Duration of insufficient early weight gain

This was the interval of time (days) from birth to maximum insufficient early weight gain.

Catch up weight gain

Catch up refers strictly to the velocity of growth after a period of growth restriction and is intended to return the infant to its previous trajectory of growth.¹⁵ As the typical weight profile following a period of poor weight gain is one of upward shift across centile lines, indicating a greater than expected rate of weight gain, we considered the use of this term appropriate in this study. The age at which the effectiveness of the catch up process was determined was about 12 months after the expected date of delivery. As it was impossible to see all the children at exactly the same age, because of difficulties in travelling etc, a limit of four weeks either side of one year was permitted. The weight profile of each baby was plotted against a reference curve for weight that was the 50th centile from the Tanner and Whitehouse data.¹⁶ The extent of catch up weight gain was obtained by the formula $((\text{weight at 1 year/weight of reference at 1 year}) - (\text{weight at maximum insufficient early weight gain/weight of reference at maximum insufficient early weight gain})) \times 100$.

Absolute weight at 1 year

Centile distribution of weights at a corrected age of 1 year were judged against the Tanner and Whitehouse standards.¹⁶

Statistical methods. Four relations were investigated by simple and multiple linear regression analyses: (1) the extent of insufficient early weight gain and absolute weight at 12 months; (2) the amount of catch up and the duration of insufficient early weight gain; (3) absolute weight at 12 months and duration of insufficient early weight gain; and (4) the product of both the extent and duration of insufficient early weight gain and absolute weight at 12 months.

Results

There were no significant correlations among any of the four relations investigated (Table 1). The centile distributions of weights at a corrected age of 1 year were distributed more in lower centile channels,

Table 1 *Relations between the weight profiles of 30 preterm babies less than 32 weeks' gestation*

Weight profile relations	r	P value
Extent of insufficient early weight gain v absolute weight at 12 months	-0.19	>0.05
Catch up v duration (days) of insufficient early weight gain	0.21	>0.05
Duration of insufficient early weight gain v weight at 12 months	-0.17	>0.05
Duration and extent of insufficient early weight gain v weight at 12 months	-0.20	>0.05

Table 2 *Centile distributions* of individual weights at corrected age of 1 year*

Centile	<3	-10	-25	-50	-75	-90
No	5	9	11	2	3	

*Standards of Tanner and Whitehouse.¹⁶

indicating that as a population the babies were lighter than might have been expected (Table 2).

Discussion

The findings of earlier studies on the size of preterm infants later in life in relation to early weight gain differ. For example, Fitzharding found that despite an initial period of poor weight gain the mean weight at a corrected age of 1 year differed little from that of control infants born at term.⁵ Baum *et al* followed up preterm babies who were drip fed breast milk during the neonatal period with its inevitable consequence, in view of the low fat content of this type of milk, of slow weight gain. At 19 months they were unable to show any difference in size compared with babies born at term.⁶ Babson, however, found that the mean weight at 1 year was below that of normal babies and concluded that little, if any, of the deficit in weight (and length) suffered during the fetal or neonatal period is made up during the first year of life.⁷ Tyson *et al* drew attention to the overall smaller size of preterm babies (and also a lower Bayley developmental score) after poor early weight gain and implied a causal relation between the two.⁹ Tudehope also found that at a corrected age of 1 year there was a lower than expected distribution of weights.⁸

The effectiveness of preterm babies to recover their early deficit in weight should not be judged by considering absolute size alone, and this misconception possibly underlies the disagreement in previous studies. Preterm births are not equally distributed

among social classes, there being a preponderance in lower social classes.¹⁷ As there is a downward gradient in parental size accompanying falling social class¹⁸ it is not surprising that a sizable number of preterm babies will also attain smaller than average size, which is not necessarily due to poor early weight gain. Genetic factors are likely to play an important part. By concentrating more on weight performance we removed this source of variation, but we were unable to find any evidence that the amount or the duration of insufficient early weight gain influences later catch up or weight at 12 months.

The need for prematurely born babies to resume their rate of intrauterine growth as soon as possible after birth provided a stimulus in the 1970s to introduce parenteral feeding into the neonatal nursery and identify more accurately their nutritional requirements. There is concern about the ability of human milk to sustain satisfactory growth because of its variable nutrient composition¹⁹ and also increasing pressure to introduce high calorie formulas into feeding regimens in the nursery. There may, however, be too much emphasis on the importance of early weight change in the evaluation of general well being. This provides an objective clinical measure of nutritional adequacy, but other major objectives of feeding should not be forgotten—namely, in the short term freedom from infection, metabolic problems, and iatrogenic disorder and in the long term fulfilment of growth and neurodevelopmental potential. Too large volumes of milk fed to preterm infants in an attempt to promote as rapid as possible weight gain early in postnatal life may be associated with two major problems in preterm infants: patent ductus arteriosus²⁰ and necrotising enterocolitis.²¹ Also by encouraging new milk formulas in preference to human milk the baby is deprived of important immune substances and exposed to foreign protein antigens. Our study provides reassuring information on the outcome of weight after a period of poor early weight gain. Whether the same can be shown to apply to other measures of growth and neuropsychological function remains to be seen. We believe that consideration of measures of growth performance in addition to absolute size should help to establish whether the programme for long term growth and development in preterm babies is adversely affected by inadequate early nutrition.

We thank Professor Stuart Donnan, Department of Community Medicine, Chinese University of Hong Kong, for his invaluable help with the statistical analyses and Miss Juliet Lee for typing the manuscript.

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Received 21 February 1985