INITIAL WEIGHT-LOSS : A PRELIMINARY ENQUIRY

BY

F. CHARLOTTE NAISH and P. WESTON EDWARDS

(RECEIVED FOR PUBLICATION APRIL 30, 1952)

There are two main theories on this subject: that the loss is due to the trauma of the birth process (Cole, 1939) and that it is due to lack of nourishment, to that delay in the coming-in of the milk which seems to be normal in human mothers. There are also two views as to what should be done about this loss, some saying that it is natural and may continue, others that it is harmful and should be stopped. At the same time some say that the average loss 'on the third day post-partum' is 3·8% of the birth weight (Kotz and Kaufman, 1939), others that it averages 4·5% over the first few days (sic) (Mackay, 1941), while yet others give estimates of normal range which imply much higher averages (Sanford, 1939). The practice of expressing the loss as a percentage of the birth weight is generally adopted, but some observers maintain that this does not altogether eliminate the influence of the birth weight and that the average loss per cent. is different for small and for large babies. Obviously, then, weight-loss is a subject on which we could do with more information and, above all, more precise information.

In search of this information we got leave from Professor Sir James Spence of Newcastle, Dr. Walter Henderson of York, and Professor Illingworth of Sheffield to make extracts from hospital records in their charge. Some 2,000 records were examined, but only 1,100 notes taken, the rejected cases being made up of (1) imperfect records, (2) stillbirths and early neonatal deaths, (3) babies hand-fed before the fourth day, (4) babies not weighed until after the fourth day and (5) babies weighing under 5 lb. at birth. (The majority of group 5 fell also in groups 3 or 4. To include the small remainder in the notes seemed likely to import a bias.) Among the 1,100 babies concerning whom notes were made, there were only nine for whom no loss of weight was recorded, and in two of these cases the record was suspect. In reporting on a preliminary enquiry one often has to confess, in the light of experience, that one has begun by taking the wrong notes. We are quite conventional in this respect. We did not appreciate soon enough what a wide range of meaning the expression 'third day

weight' may have when translated into hours-after-birth. It may mean anything from 44 hours to 70 hours after birth. Unfortunately, the notes we had made in the hospital record-room did not allow us to sub-divide these third day weights except into two broad groups, centred on 52 hours and on 64 hours. It seemed safe to assume that if the supply of mother's milk affected the weights at all within 70 hours of birth, its effect would be much less on the 52-hour group than on the 64-hour group, and that therefore the earlier group should be the one mainly studied. This division reduced the available notes to 453.

We had assumed to begin with that one hospital might differ considerably from another in the proportion of babies hand-fed before the fourth day but that, once those were eliminated, loss of weight would not differ much from one hospital to another, and that, accordingly, by taking notes from several sources we should get a representative sample of hospital babies in general. It was necessary to find out whether the notes conformed to these assumptions. Since circumstances had compelled us to interrupt the work at Sheffield at a very early stage, the main question was whether the Newcastle data and the York data could legitimately be combined and treated as a single series of hospital babies. There were 230 Newcastle babies (mean loss 7·15* and standard deviation 2·604*) and 170 York babies (mean loss 6·24* and standard deviation 1·908*).

The chance of two samples so different in their standard deviations being drawn from a single uniform population is less than 3 in 10,000,† and therefore it would be quite illegitimate to combine them.

This unexpected result left the 230 Newcastle babies as the longest series—a very disappointing outcome after taking 1,100 notes. However, the series is not so small that it cannot yield any results. These are mainly negative, but it seemed worth

* Weight lost is everywhere expressed as a percentage of the birth weight.

† Fisher's z-distribution was used for this estimation.

while to make them public if only to prevent other enquirers from wasting effort in seeking information where we are confident there is none to be found.

Recent correspondence in the medical journals leads us to remark at this point that in our opinion there is no virtue in the routine application of certain statistical procedures to any material whatever that may come to hand, especially when it involves the application of refined methods to crude data or to obvious questions. Accordingly we have tried to use the simplest methods that seemed adequate to the case. And by 'simplest' is meant not so much easiest to carry out as easiest to explain; for, while it is bad practice to break a butterfly on the wheel, it is bad manners to load the body of a paper with technicalities which the general reader is not expected to follow.

Whenever babies are in question, one has to consider whether the age of the mother, the position in the family, or the weight at birth have any bearing on the matter in hand. To decide these questions we have arranged the data in double-entry tables, of which the one referring to the ages of the Newcastle mothers is reproduced as Fig. 1. If low ages were associated with low losses, and vice versa, the marks in such a diagram would show some degree of banding; and if low ages were associated with high losses that would only change the direction of the band. The purpose of such a diagram, then, is to enable one to see whether any banding is present or not. (That is why numbers are not given in the squares; they have no diagrammatic value.) In the present instance the diagram is so obviously of the

'swarm of bees' type that there is no need of any calculation to show that the factors are unrelated.

The relation between birth weight and weight-loss might be treated in the same way, but that the printing costs of this method of presentation are high. Therefore, having prepared a double-entry table as before, we have summarized it below by giving the average loss for each row of the full table—technically, the *array means*. The hypothesis that these two factors are related is generally equivalent to the hypothesis that each birth weight group has its own average weight-loss, differing from the general average (*grand mean*) according to some detectable pattern. It is at once evident from the figures below that the array means differ from the grand mean very little, and quite irregularly, so that they give no support to the hypothesis.

Birth Weight Group (lb.)	Number of Babies	Average Loss
5½ but under 6	21	6.76
6 " " 6½	24	7.0
6½ " " 7	46	7.7
7 " " 7½	39	7.13
7½ " " 8	33	6.67
8 " " 8½	30	7.33
8½ " " 9	20	6.6
" " over 9	17	7.06
All groups	230	7.15

From the point of view of position in the family the data can only be divided into first births and later births, since the numbers of third and higher births are too small to be considered separately.

FIG. 1.—Chart of all babies in the Newcastle series weighed at 52 ± 6 hours distributed by weight-loss and by mother's age.

There were 116 first births (mean loss 7.18, standard deviation 2.62) and 115 later births (mean loss 7.09, standard deviation 2.35), and we have to ask, on the hypothesis that birth rank does not really make any difference, what would be the chance of drawing from a single population two samples differing to this extent in their standard deviations? The chance is greater than 11%.* The customary level of significance, or acceptable risk of error, being only 5%, the observed difference would not normally be thought to discredit the negative hypothesis and to justify the assumption that birth rank did make a difference. It is evident that the difference between the means does not justify it either.

These routine points disposed of, it was natural, in view of the theory that weight-loss depended on the trauma of the birth process, to consider next the length of the first stage of labour. It is worth recording that simple inspection of the double-entry table prepared from the Newcastle cases would have led us to dismiss length of labour as an irrelevant factor. However, in order to avoid printing the full table, we prepared the following summary:

Hours	Cases	Mean Loss
under 6	61	7.1
6 but under 12	62	7.26
12 " " 18	33	6.55
18 " " 24	12	6.75
24 " " 36	27	7.82
36 " " 48	7	8.143
48 " " 60	4	8.25
(Mean hrs. 13.6)	206*	7.19

* Only normal deliveries were included in the table.

In this summary, though the array means do not differ much from the grand mean, it can be seen that there is an apparent regular increase from the third group onwards; and, although the later array means rest on only a small number of cases, it seemed advisable to investigate this point further. In such a case there are two distinct things to be measured: the extent of the suggested relationship, and its reliability. The babies in this series show considerable variation in the amount of weight lost, and the extent of the relationship is the proportion of this variation which might be explained by attributing it to length of labour. We decided to measure this only over the portion of the original table where a trend appeared: that is, over the 83 cases in which first stage of labour lasted 12 hours or more. This does not exaggerate the trend provided the conditions of measurement are clearly stated. It was found that *in those cases where labour lasted 12 hours or more, length of labour could explain less than*

7% of the variation in weight-loss that had been observed.*

The reliability of the suggested relationship is determined by calculating the chances of obtaining such figures by accident in samples of the same size if there were no relationship between length of labour and weight-loss in the population from which the samples were drawn. It was found that over 10% of samples might, by accident, show an apparent relationship of the same extent. However, it must be recognized that the test of reliability refers only to the measurable extent to which the array means depart from the grand mean, not to the element of detectable pattern in their departure. Consequently the fact that so little of the observed variation in weight-loss could be explained by referring it to length of labour is the more damaging of the two results just discussed. To conclude, summarizing the double-entry table and investigating the resulting figures, led in the end to the same conclusion as simple inspection of the original table.

The possibility of a relationship between length of labour and weight lost was also studied with reference to the York data, because of the prima facie plausibility of the idea and because it had been shown that the York and Newcastle babies were distinct series. The double-entry table was arranged so as to reduce the variation in the number of cases on which the array means were based. The summary showed:

Average Hours of Labour	Number of Cases	Mean Loss
2 hour 20	20	5.9
4 " 50	21	7.0
7 " 10	23	7.22
9 " 00	21	6.24
11 " 20	20	5.9
13 " 50	13	5.23
17 " 45	12	6.83
23 " 00	12	5.33
28 " 25	12	6.00
46 " 00	12	6.1
Gr. mn. = 13.8	166	Gr. mn. = 6.265

There is no suggestion of trend here, so the York data give even less support to the supposed relationship than the Newcastle data did.

It was natural to wonder if some of the variation in weight lost could not be explained simply by the different intervals after birth at which the weights

* The term 'variation' used in the text is the English word and is used with its ordinary dictionary meaning. For the purpose of calculating the proportion, the variation was measured as 'variance' using the mean of the 83 cases, which was 7.205. Crude $\eta^2 = 0.456$

$\frac{6.859}{0.0665}$ = Pearson's correction for number of categories reduces this figure to 0.0435. Significance was tested by conversion to an analysis of variance through the formula

$$z = \frac{1}{2} \log_e \left(\frac{\eta^2}{1-\eta^2} \cdot \frac{N-p}{p-1} \right)$$

P was found to exceed 10%.

* Fisher's z-distribution was used for this estimation.

were taken. We regretted very much that the notes taken at the hospitals did not enable us afterwards to subdivide the time more finely. However, we had some figures referring to the previous and to the following 12-hour periods:

		Mean	S.D.
40 hours $\pm$ 6	All deliveries (53)	6.3	2.35
52 hours $\pm$ 6	All deliveries (233)	7.15	2.6
	(Normal deliveries (206))	7.19	2.58
64 hours $\pm$ 6	Normal deliveries (208)	7.1	2.61

Seeing how small is the difference between the periods, it is very unlikely that there is any important variation within the periods.

Having failed to relate loss of weight to the other measurables usually given in the case notes, we must treat it for the time being as an independent characteristic of babies, and describe it as it occurs among the healthy normal infants in a hospital. (The nature of the exclusions made in taking the original notes ensures that the figures refer to babies who were considered fit for the routine procedures of the wards.) Though we repeat here the means and standard deviations already given, we believe that the most convenient form for the simple description of a clinical phenomenon is the cumulative percentage table as follows:

	Newcastle	York
10% of the babies lost	10.0	8.7 or more
30% of the babies lost	8.4	7.1 or more
50% of the babies lost	7.0	6.2 or more
70% of the babies lost	5.8	5.2 or more
90% of the babies lost	4.0	4.0 or more
Mean	7.15	6.24
S.D.	2.6	1.9

When the differences between these two series were first noted, no explanation could be offered, but now that so many factors have been shown to be irrelevant, we may hazard that it is due to the giving or withholding of water during the period before lactation begins. In an effort to reduce cross-infection in the wards, the giving of sterile water from a spoon was stopped at Newcastle, except on specific instructions from the physician in charge, when it was entered on the notes as an exceptional procedure. At York it was regarded as a routine, given at the discretion of the nursing staff, and not entered. There are no figures on which to estimate whether this might be a sufficient explanation.

The chief point that we believe we have established in this preliminary enquiry is that no light is likely

to be thrown upon initial weight-loss by the study of existing records. The problem demands records *ad hoc*.

It is evident that such records would need to give a weight taken (a) at a shorter interval after birth; (b) at a more closely defined interval after birth; (c) at the prescribed interval in a high proportion of the babies, with a definite reason for the exclusions. Concerning the form of such records, we would also like to suggest that if, in fact, a baby's regime is determined by a subjective assessment of his general condition, based on factors which are not recorded because they are not measurable, then it is better to acknowledge the fact, and give the assessment in the records. Grading by an experienced judge can be very accurate, provided the scale has not more than seven points (and better still five), and in any case it is better than a series of measured quantities which are not the grounds of the action taken.

A similar problem arises with regard to the first stage of labour. Its length is measurable, and this is taken, for lack of anything better, as an index of 'severity' or 'difficulty'. A direct assessment of severity would have as good a chance of being correct.

Given a series of records designed for the investigation of this problem, we should certainly direct our attention again to the influence of the labour on the weight lost. The figures given in the present paper show that this influence cannot be deduced from existing hospital records, but they by no means show that it does not exist. A 1 in 10 chance that the apparent effect of labour may be due to accidents of sampling is a high probability if one is thinking of drawing conclusions and taking some action thereon but it is quite a low probability if one is merely thinking of investigating further. Moreover, the known relation between birth rank and easy labour makes the difference between first and later births with regard to weight-loss (reported above with the same probability level) interpretable as a confirmation of the importance of the labour. Finally, the records examined give us absolutely no other lead as to where to start.

However, an investigation requiring records *ad hoc* is beyond the scope of outside enquirers like ourselves. We can only hope that others will take the matter up at the point where we are obliged to leave it.

REFERENCES

- Cole, W. C. C. (1939). *Surg. Gynec. Obstet.*, 68, 179.
 Kotz, J. and Kaufman, M. S. (1939). *J. Amer. med. Ass.*, 113, 2035.
 Mackay, H. M. M. (1941). *Archives of Disease in Childhood*, 16, 166.
 Sanford, H. N. (1939). *J. Amer. med. Ass.*, 113, 470.

Dr. Naish's address is 18 St. Saviourgate, York.