CLXXXIX. A STUDY OF THE COMPOSITION OF HUMAN MILK.

THE INFLUENCE OF THE METHOD OF EXTRACTION ON THE FAT PERCENTAGE.

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THE fat content of both cow's and human milk is a subject on which much work has been done, and though certain facts are now well established there is still no clear understanding of the circumstances which determine the normal range of variation or knowledge of the conditions which determine these comparatively wide limits. In the course of our study on the composition of human milk in the early stages of lactation [Lowenfeld *et al.*, 1927; 1928] it was noticed that the method of extraction of the milk sample had a considerable influence on the percentage of fat, although no other constituent was affected by this factor. Since this factor had not to our knowledge been investigated by any previous worker, it occurred to us that herein might lie the probable explanation of the variations in the fat percentage hitherto recorded. We decided therefore to undertake a more intensive study of the fat content in human milk throughout the whole course of lactation, paying special attention to the method adopted for obtaining the milk sample. The present paper is a record of our results and the conclusions which they suggest.

METHODS OF OBTAINING MILK.

The two methods used for obtaining the samples of milk (for convenience called the "extraction" of milk) throughout the work were either digital expression or gentle use of the breast pump, and in every case where milk dripped from the breast a sample of this milk was also collected in addition to the other samples.

These two methods were adopted after critical observation of the actual process of suckling by an infant. This process consists of two factors, the direct pressure exerted by the gums of the baby upon the nipple and the areola of the breast, and the suction action exercised by tongue and cheek drawing on the openings at the end of the nipple. Digital pressure and gentle suction from a pump used without pressure upon the breast represent the nearest approach which can be made artificially to reproduction of these two factors in the normal process. Systematic comparison made of the percentages of fat in samples of milk extracted by these two methods, under similar conditions, at once showed very marked differences. Indeed, the differences were so striking that we have come to the conclusion that in the method of extraction is to be found the chief explanation of the wide variations shown in fat figures obtained by different workers.

Material.

Twenty hospital cases were used for investigation of the milk of the first fortnight of lactation, and a continuous study of the milk of the same mother throughout this period was thus possible.

Owing to irregularities in attendance at hospital or clinic, it was not possible to achieve the same continuity in the later period of lactation. Nevertheless, every effort was made to examine the milk of the same woman over as many months as possible. By a combination of the figures obtained from the two sets of investigations, material sufficient for a general survey of the problem of the fat percentage in milk under varying conditions and during the whole course of lactation has been obtained.

The milk of 51 mothers was examined for the percentage of fat, protein, sugar, calcium, phosphorus and ash, and the results of this work, except for that on fat, have already been recorded [Lowenfeld *et al.*, 1927; Widdows *et al.*, 1930]. The milk samples were obtained from nursing mothers in the lying-in wards of the Obstetric Unit of the Royal Free Hospital, from those attending the Shoreditch Carnegie Welfare Settlement, and the Mothercraft Training Society, Cromwell House, Highgate.

Careful notes were taken of the mother and child so that all abnormal factors could be excluded. In every instance, except for ten cases, the baby was thriving satisfactorily. In these ten cases an attempt was made to determine the cause of the nutritional disturbance in the infants.

To maintain uniformity of conditions the milk was always taken for analysis at the same feeding time, and the same interval was observed between the times of feeding. The importance of these factors had been shown in the case of cows by Eckles and Shaw [1913] who state that the percentage of fat is usually highest about midday, and in a Bulletin recently issued by the Ministry of Agriculture and Fisheries [1931] instances are given from the work of Gilchrist [1925] and Mackintosh [1925] fully confirming this diurnal variation. In the case of human milk, Helbich [1911] showed the highest percentage to be at 10 a.m. or 2 p.m., and more recently Deem [1931] has again emphasised this, showing that the percentage of fat is at a maximum at 10 a.m., nearly the same at 2 p.m., and at a minimum at 6 a.m.

In our work all the samples in the early days of lactation were taken at 10.30 a.m. and during the later periods at 2 p.m.

The taking of the sample, except in the case of the Mothercraft Training Society, was carried out by one of us (M. F. L.) and the biochemical analysis by the other (S. T. W.).

Every visit of each mother necessitated, as will appear later, at least four estimations of fat, and where milk dripped from the breast a sample of this dripped milk was also taken for estimation. In all, 276 samples taken before and after the baby had fed and 18 dripped samples were collected and analysed.

Analytical methods.

Gottlieb's method was used for the estimation of the fat.

To study the influence of the method of extraction on the fat content of the milk 216 samples were examined. These were obtained according to the following procedure.

From one breast a sample sufficient for analysis was taken by hand, the amount varying from 2 to 30 cc. according to the average yield of the subject.

The baby was then allowed to feed from 2 to 5 minutes, and the breast was then finally emptied by hand, the total resulting fluid being considered as the second sample.

From the other breast also a sample was taken before feeding, by hand; the baby was allowed to feed for the same length of time as before, and the final sample, which emptied the breast, was obtained by gentle use of the pump, avoiding pressure upon the breast.

The use of the two different methods, keeping the other conditions constant, enabled the bearing of each upon the fat percentage to be studied. On the one side a uniform method of extraction was employed, namely digital expression, for both the samples. On the other side digital expression was used in obtaining the first sample and suction by the breast pump for the last sample.

Our previous work has shown that in normal cases the composition of the milk given by either breast is approximately the same. Assuming this to be generally the case in all women, if the manner of extraction were immaterial, even although the exact figures of the percentage might differ on either side, a rise in the fat percentage on one side would be paralleled by a similar degree of rise on the other. It is therefore the question of the relation of the method of extraction to the production of the degree of rise in the fat percentage between the beginning and end of a feed with which we are at present concerned.

Before considering our results, certain factors that occur during breast feeding must be taken into consideration. Stimulation of one breast produces immediate changes in the other breast, and in certain women the breast of one side will begin to leak as soon as extraction starts from the other; loss of fore-milk thus occurs from the second side. Furthermore, the amount taken by the baby on each side is impossible of exact regulation. Thus, in spite of all care, the two samples taken from either side cannot be exactly equivalent. Apart from these discrepancies, which were beyond our control, all other conditions were kept uniform for the two sides. A study of the figures obtained shows that in very few cases is there a general agreement in the degree of rise of fat on the two sides. Indeed it is apparent that the change of method from hand to pump for the last sample of the second side materially affects the normal rise in the second sample of the side under consideration.

Experimental results and their analysis (Tables I, II and III).

In Table I (A, B and C) are given 25 illustrative instances representing 22 women, where the effect of extracting the samples by suction with a minimum degree of pressure upon the breast was either to lessen the expected rise in fat percentage of the second sample or actually to obliterate it.

In Table I A it will be seen that there is an increase in the percentage of fat in the samples taken after the feed, whether extracted by hand or pump. This is in accordance with the findings of previous workers both in the case of cows' milk [see Eckles and Shaw, 1913; Jensen, 1906; Wellmann, 1911; Min. Agric. Fish., 1931], and human milk [see Adriance, 1897; Söldner, 1896; Schlossmann, 1900; 1902; Myers, 1927]. We ourselves have found with regard to the individual feed that in every case in which a single method of extraction was used throughout the taking of the milk, whether it were breast pump, digital pressure, or a mechanical milker[1], the later portion of the milk was richer in fat than the earlier. It is now an accepted fact that the strippings in any milk extraction show a higher percentage of fat than the middle or early milk of the same extraction.

[1] Dr Chisholm very kindly tested this method for us in Manchester.

Table I.

(The following abbreviations are used in the tables: L, left; R, right; B, before feed; A, after feed; H, hand extraction; P, pump extraction; m, month; w, week.)

Case (age of baby below)	Breast	Before feed: Volume in cc.	Before feed: Method of extraction	Before feed: % of fat	After feed: Volume in cc.	After feed: Method of extraction	After feed: % of fat	Rise in % of fat	Reduction of expected % increase (after pump extraction)
				A					
1. (H 2)	R	7	H	5·00	15	H	8·88	3·88	2·42
	L	7	H	3·79	13	P	5·25	1·46	
2. (R)	L	4·5	H	3·12	3·3	H	9·18	6·06	3·34
9 m	R	4·5	H	4·69	2·8	P	7·41	2·72	
3. (S)	R	22	H	0·73	36	H	4·19	3·46	1·54
7 m	L	15	H	3·00	14	P	4·92	1·92	
4. (T)	R	11	H	1·09	12	H	6·16	5·07	1·83
5 w	L	9·5	H	4·52	11	P	7·76	3·24	
5. (Ga)	R	18	H	3·06	23	H	5·69	2·63	1·30
3 w	L	11	H	4·22	7	P	5·55	1·33	
*6. (Co)	R	11	H	3·74	11	H	11·13	7·39	4·11
5 m 3 w	R	14	H	2·06	5	P	5·34	3·28	
				B					
7. (S. i)	R	9	H	3·97	10	H	8·73	4·76	0·64
	L	13	H	5·58	1·8	P	9·70	4·12	
8. (S. ii)	L	7	H	4·97	15	H	6·42	1·45	0·08
	R	28	H	4·13	1·5	P	5·50	1·37	
9. (J. i)	R	10	H	3·62	5·5	H	8·40	4·78	2·63
2 m	L	22	H	2·60	1	P	4·85	2·25	
10. (J. ii)	R	7·5	H	2·65	7·5	H	5·21	2·56	1·52
2 m 3 w	L	2·3	H	2·60	1·4	P	3·64	1·04	
11. (N. R.)	R	11	H	5·07	22	H	8·29	3·22	1·05
3 m	L	14	H	5·64	1·7	P	7·81	2·17	
12. (Y)	R	11	H	4·61	22	H	6·74	2·13	1·02
5 w	L	13	H	4·09	5·5	P	5·20	1·11	
13. (R. R.)	L	6·2	H	4·12	12	H	6·92	2·80	1·21
3 m	R	15	H	4·32	5·5	P	5·91	1·59	
14. (B)	R	8	H	1·26	20	H	4·93	3·67	1·20
	L	5·5	H	3·21	2·8	P	5·68	2·47	
15. (Cp)	R	6	H	2·40	20	H	5·00	2·60	1·24
3 m 3 w	L	11	H	4·08	5	P	5·44	1·36	
16. (Po)	R	9·5	H	1·28	9	H	4·60	3·32	2·47
7½ m	L	6	H	4·48	2·5	P	5·33	0·85	
17. (Sh)	L	10	H	2·29	8·5	H	7·00	4·71	3·28
	R	7	H	5·73	2	P	7·16	1·43	
				C					
18. (Ha)	R	16	H	4·73	3	H	6·60	1·87	1·85
3 m	L	6	H	6·67	3·5	P	6·69	0·02	
19. (Bl)	R	4	H	1·71	7·5	H	3·59	1·88	1·37
	L	3·5	H	2·73	3·5	P	3·24	0·51	
20. (Kn)	L	5	H	4·88	11	H	8·76	3·88	3·40
5 w	R	11	H	7·62	1	P	8·10	0·48	
21. (H. i.)	R	7	H	3·07	15	H	5·32	2·25	1·95
	L	7	H	2·88	13	P	3·18	0·30	
22. (Co)	L	5	H	3·54	6·5	H	6·30	2·76	2·72
9 w	R	4	H	2·12	2·5	P	2·16	0·04	
23. (Si)	L	7·3	H	1·66	26	H	4·70	3·04	2·59
2 m 2 w	R	6	H	6·49	10	P	6·94	0·45	
24. (G)	L	5·5	H	2·24	15	H	4·49	2·25	1·98
7 w	R	4	H	3·00	7·5	P	3·27	0·27	
25. (Ra)	R	13	H	2·01	9	H	4·91	2·90	2·60
3 m	L	12	H	5·20	3·5	P	5·50	0·30	

* As the patient had only one breast, the figures were taken on two different occasions, very close together, from the remaining breast.

Volumes. In cases 1, 2 and 4, the volumes of the samples are approximately equal. In 5 and 6 the question of the volumes falls into a grouping to be considered later. In each case the sample taken by pump contains less of the middle milk than that taken by hand.

On careful examination, however, the extent of the rise in fat will be found to be much less on the side where the final extraction was made by pump than that on the side taken by hand.

Table I B shows 11 cases where the volume obtained in the sample extracted by pump in the after-feed is very much smaller than that of the sample obtained by hand, indeed, in many cases the pump sample may be considered to consist of strippings only. In spite of this fact, it will be found that the rise to be expected in the after-sample, and shown definitely in that taken by hand, is reduced. To this table should be added cases 5 and 6 (Table I A) already referred to.

In the case of the 8 women whose samples of milk are shown in Table I C, the fat percentage of the sample taken by pump after the feed, when compared with that of the sample taken by hand before the feed, shows so small a rise (0·02 to 0·51 %) as to represent, within the limits of experimental error, practically stationary values; although on the other side at the same feed, the samples taken by hand show a consistent rise from 1·87 to 3·88 % over that taken by the same method before the feed on that side.

In certain women the process was carried even further, as will be seen in the 7 cases in Table II. Here, although on the side where hand extraction was used for both the fore- and after-samples, the normal and expected rise in the fat

Table II.

		Before feed			After feed			
Case	Breast	Volume in cc.	Method of extraction	% of fat	Volume in cc.	Method of extraction	% of fat	Rise or fall in % of fat
26. (La)	R	5·3	H	1·86	12	H	4·23	2·37
	L	6·5	H	3·16	5·5	P	3·13	−0·03
27. (Va)	R	8	H	5·83	6·5	H	9·87	4·04
	L	7	H	4·91	3·5	P	4·40	−0·51
28. (O. F.)*	L	7·5	H	1·78	36	H	5·28	3·50
	R	12	H	7·264	4	P	7·12	−0·14
29. (Fo)	L	10	H	4·81	7·5	H	9·80	4·99
	R	15	H	4·16	15	P	2·13	−2·03
30. (Sm)	L	4·5	H	1·19	6	H	4·36	3·17
	R	3	H	3·27	5·5	P	2·14	−1·13
31. (Ba)	L	4·5	H	0·64	11	H	2·33	1·69
	R	5	H	3·16	2·5	P	2·96	−0·20
32. (Wi)*	L	9·7	H	2·85	11	H	4·02	1·17
	R	9·5	H	6·26	11	P	5·89	−0·37

* In cases 28 and 32 there was a very marked difference in % of fat in "before feed" samples in the two breasts, probably due to feeding habitually from one breast only.

percentage of the after-sample occurred, the rise ranging from 1·17 to 4·99 %; on the other side where hand and pump were used for extraction, not only did no rise occur, but the percentage of fat in the after specimen was actually lower than that in the one taken before the feed.

As is usual in dealing with the human organism, the expected does not invariably occur, and we have had a few cases in which extraction by pump has not affected the percentage of fat in the sample taken after the feed in the manner to be expected. In Table III are given five such cases.

Table III.

		Before feed			After feed			
Case	Breast	Volume in cc.	Method of extraction	% of fat	Volume in cc.	Method of extraction	% of fat	Rise in % of fat
33. (Hy)	R	8	H	3·59	17	H	5·02	1·43
	L	12	H	2·62	5·5	P	4·09	1·47
34. (So)	L	7·5	H	2·69	15	H	3·62	0·93
	R	4	H	3·30	8	P	4·34	1·04
35. (Gr)	R	2·5	H	3·70	9	H	6·99	3·29
	L	10	H	3·32	6	P	6·68	3·36
36. (Ho)	R	15	H	2·50	13	H	4·17	1·67
	L	7·5	H	2·70	7·5	P	5·00	2·30
37. (Yt)	R	6	H	4·70	20	H	5·09	0·39
	L	10	H	2·42	14	P	4·28	1·86

Although the influence of the method of extraction upon the percentage of fat was shown unmistakably in all but the above cases, yet it is discernible even in these. In all except 35, it will be noted that the volumes after extraction by pump are considerably smaller than those taken by hand. In view of this fact, it would be expected that the normal rise shown by any method of extraction would be greater between a sample taken before feeding, of volume 12 cc., and a sample taken after feeding of volume 5·5 cc., than in a sample of 8 cc., before and a sample of 17 cc. after feeding. Nevertheless the actual rise in the former case is practically the same as in the latter. Indeed in cases 33, 34 and 35 the rise on both sides, within the limits of experimental error, is equal. In cases 36 and 37 we present the only cases found in our total series in which the percentage of fat in the after-sample taken by pump is significantly greater than in the sample taken by hand. It will be noted that the volumes of the after-samples in extraction by pump are considerably smaller in both cases than those taken by hand.

Deduction from above experimental data.

As has been pointed out already, the normal action of a baby feeding upon a breast can be analysed into two factors: pressure and suction; and it would appear from a study of the preceding tables that the pressure is the important factor in the production of a high percentage of fat. The greater the pressure apparently the steeper will be the rise in the fat percentage. Suction employed alone, on the other hand, tends to lower the percentage of fat. The larger, therefore, the element of suction in the act of extraction, the smaller apparently will be the ultimate rise in the fat percentage.

As will be indicated later, there appears to be an inverse ratio between the volume of milk in the breast at any time during any one feed and the percentage of fat in the sample. The larger the quantity of milk at any moment, the lower the percentage of fat in that milk—the smaller the quantity of milk, the higher the fat content. In the experiments just described, these factors have been arranged so that they act in opposition to each other.

It is suggested that the following conclusion may be formulated from these data.

In any given sample of milk, other factors being equal, the percentage of fat present will depend inversely upon the quantity of milk present in the breast at the time of taking the sample, and directly upon the degree of pressure exerted upon the areola and nipple in the process of extraction.

If this be true, then milk which has dripped from a breast, that is to say, which has been extruded in answer to conditions within the gland and not by any means of extraction from without, should theoretically give the lowest percentage of fat of all, and this is exactly what occurs.

Experimental results on dripped milk.

Table IV shows the relation of the percentage of fat in milk which has dripped from a breast to that extracted by other means. In every case it will be seen that the milk which drips is lower in its fat percentage than that obtained by extraction, whether by pump or hand.

Table IV.

b. f., before feeding; a. f., after feeding; D, dripped.

Case	Breast	Method of extraction	% of fat	Method of extraction	% of fat	Rise in % of fat
38. (Je)	R	D (b. f.)	0·26	H (b. f.)	2·94	2·68
39. (Kn)	L	D ,,	2·77	H ,,	4·88	2·11
40. (Co)	L	D ,,	1·57	H ,,	5·66	4·09
41. (Wi)	L	D ,,	1·78	H ,,	3·92	2·14
42. (Te)	R	D ,,	0·35	H ,,	1·09	0·64
43. (Pe)	R	D ,,	2·24	H ,,	5·52	3·28
44. (Wa)	R	D ,,	1·82	H ,,	2·36	0·54
45. (Ha)	R	D (a. f.)	1·12	H (a. f.)	4·02	2·90
46. (Gr)	R	D ,,	2·54	H ,,	5·75	3·21
47. (Gi)	L	D ,,	1·65	H ,,	4·49	2·84
48. (Gr)	L	D ,,	3·64	P ,,	6·16	2·52
49. (Sm)	L	D ,,	2·30	H ,,	4·36	2·06
50. (Hv)	R	D ,,	2·30	H ,,	5·02	2·72

As will be seen from Table IV, the first 7 cases show the percentage of fat in milk which has dripped to be lower than in milk taken by hand, before feeding took place or any other milk was extracted. In the last 6 cases the stimulation of suckling the baby at one breast caused the other breast to drip. These dripped samples so obtained are compared with samples previously taken from that same breast by hand or pump. It is of interest that in cases 47 and 50 milk taken by hand before feeding gave 2·24 and 3·59 % of fat, that is, 0·59 and 1·29 % more than the milk which dripped after feeding. In all other cases the fat percentage in the dripped milk was less than that in the specimen taken immediately after the feed either by hand or by pump.

It may therefore be concluded that when samples are taken from any given breast, all conditions other than the method of extraction being similar, a specimen of milk which has dripped from a breast will show the lowest proportion of fat obtainable at that moment. Nevertheless, the figure in itself need not actually be low, since the woman under examination may be one of those women who, under all circumstances, produce a high level of fat. This was shown in a case (Ra) in which the percentage of fat in the dripped milk before feeding was 4·39 rising to 6·26 and 8·63 in the before- and after-specimens taken by hand; or another case (R. R.) in which the dripped sample before feeding showed a percentage of 3·18 rising to 4·69 in the hand sample before feeding and 7·41 in the pump after-sample.

Adjustment to the method of extraction, though it occurs eventually, is of course never immediate. If a very small sample be taken by hand immediately after the dripped sample, the rise in the fat percentage, though definite, will in all probability be slight. As for instance in the case (So) when the percentage in

the sample dripped before feeding was 4·86 rising to 4·96 in the sample taken by hand before, and 6·42 in the sample taken by hand after, feeding; and another case (Pa), where the dripped sample before feeding showed a percentage of 3·15 rising to 3·55 and 5·33 in the samples taken by hand before and after feeding.

OTHER FACTORS INFLUENCING THE PERCENTAGE OF FAT IN THE MILK SAMPLE.

There are certain other factors which have an influence on the percentage of fat in the sample of milk extracted, when the same method of extraction (either digital pressure or breast-pump) is employed.

These factors have been taken into account when considering the effect of the mechanism of the extraction upon the composition of the sample.

1. *Period of lactation.* It has been found that the proportion of fat in the milk of all multiparae investigated rises between the first and fourteenth days. The nature of the rise is shown in Table V.

Table V.

Case	Day of lactation	% of fat	Case	Day of lactation	% of fat
51 (J)	2	1·40	53 (H)	6	0·44
,,	3	1·90	,,	7	3·10
,,	4	2·57	,,	8	3·35
,,	5	2·82	,,	9	3·80
,,	9	4·50	,,	10	4·60
52 (P)	5	3·26	54 (Pd)	2	2·92
,,	6	4·20	,,	5	3·40
,,	7	3·73	,,	6	3·42
,,	8	3·49	,,	7	3·88
,,	9	4·15	,,	8	4·15
,,	10	5·43	,,	12	4·58
			,,	13	4·95
			,,	14	4·72

In the case of primiparae it is found that the percentage of fat in the early part of the feed is also as a rule higher than at the end, but, as shown in Table VI, this is not invariable.

Table VI.

	Early milk of primiparae				
			% of fat in sample		
Case	Day	Breast	Before feed	After feed	Difference
55. (F) primipara	1st	R	0·95	0·53	−0·42
,, ,,	2nd	L	1·66	1·26	−0·40
,, ,,	3rd	L	2·73	3·35	+0·62
56. (P) ,,	2nd	R and L	3·13	2·72	−0·41
,, ,,	4th	L	3·04	4·56	+1·52
,, ,,	5th	R	1·92	4·16	+2·24
,, ,,	14th	L	3·55	5·89	+2·34
57. (Pd) ,,	2nd	R	7·14	5·02	−2·12
(Small ,,	2nd	L	6·92	5·74	−1·18
quantities)	6th	R	5·44	5·60	+0·16
,, ,,	6th	L	9·98	8·66	−1·32
,, ,,	7th	R	4·36	6·10	+1·74
,, ,,	7th	L	3·64	9·02	+5·38
58. (J) multipara	3rd	R	1·57	2·12	+0·55
,, ,,	4th	L	2·57	3·09	+0·52
59. (Bk) ,,	2nd	L and R	3·50	6·05	+2·55
,, ,,	3rd	R	2·97	4·09	+1·12

2. *Individuality of women.* In the case of the milk of women examined during the first fortnight of lactation, it was found that although the mean percentage of fat in all cases rose from the first to the fourteenth day, yet in some cases the highest figure shown was between 3 and 4 %, although in other cases the percentage rose quickly to over 4 % and then to 5 % and over 6 %.

In the later periods of lactation, although two different methods of extraction were being used, the same general phenomenon was noted. In some women the lowest value for the fat obtained was rarely less than 4 % (usually between 5 and 6 %), and in some women over 7 %. In others the lowest value was less than 3 %, falling generally between 3 and 4 % and rarely rising above 4 %.

These observations suggest that some women throughout their whole lactation period will have normally a much higher percentage of fat in their milk than others. This individual variation has been observed also in the case of cows [see Min. Agric. Fish., 1931].

3. *Volume in the breast.* Emphasis has been laid in the foregoing work on the quantity of fluid obtained at any one extraction, and it might have been expected that a difference in total quantity habitually secreted would be reflected in the fat content of the milk.

Engel and Frehn [1910] consider that there is such a relationship, and that the milk output and the fat content are inversely related to one another. From a study of our own cases, there seems no such clear relationship. In Table VII are

Table VII.

Case	Age of baby	Sample	% of fat
60. (P)	First two weeks of life	2	6·17
,,	,,	3	4·22
,,	,,	4	4·50
,,	,,	7	7·40
,,	,,	8	5·82
,,	,,	9	5·20
61. (F)	,,	1	0·74
,,	,,	2	1·45
,,	,,	3	3·00
,,	,,	7	2·44

given the average percentages of fat obtained from samples from two different women on successive days, and although in each the quantity of milk was less than 10 cc. a wide difference is shown in the percentages of the fat.

If the usual quantity of fluid secreted by the breast of an individual suddenly changes, that is to say, if in a mother who habitually secretes a large amount of milk the quantity quickly decreases, or *vice versa*, then we have found that this change will affect the fat and be reflected in a rise or fall respectively. Thus, in one case when the fat percentages on the 8th and 9th days after parturition were 4·92 and 5·03 respectively, the volume of milk in the breast was small in consequence of extreme heat and profuse sweating. On the 10th day, however, after the intake of a great deal of fluid, the volume of milk in the breast suddenly rose and the percentage of fat fell to 3·8 %. The figures in Table VIII further illustrate this point.

Therefore it would appear that the final percentage of fat occurring in the milk at any given period during a feed is the product of several factors—the nature of the habitual yield of the individual woman, the place in the feed, and the mechanics of the process of extraction.

Table VIII.

Case	Volume in cc.	% of fat
62. (F)	3·3	2·73
,,	5·5	3·35
,,	20	1·52
63. (P)	Quantity under 10	6·17
,,	,,	4·22
,,	,,	4·50
,,	,,	7·40
,,	,,	5·82
,,	,,	5·20
,,	38	2·98

The above work, which was in the first instance undertaken to elucidate the variations in the fat content of milk recorded by many other workers in this field, has proved itself of value from the clinical point of view. This side of the work will be recorded in a separate communication.

Conclusions.

From our results it is suggested that the following conclusions may be drawn.

1. Differences in the method of extraction of a sample of milk appear to account for the wide variations in the fat figures hitherto obtained by different workers.

2. In any given sample of milk, other factors being equal, it would appear that the percentage of fat present will depend inversely upon the quantity of milk present in the breast at the time of taking the sample, and directly upon the degree of pressure exerted upon the areola and nipple in the process of extraction. The lowest percentage of fat will be found in milk which has dripped spontaneously from the breast.

3. There appears to be an individual variation in the average fat content of the milk of different women.

4. There would seem to be no clear relationship between a permanently high or low milk yield and the proportion of fat in the yield, though this proportion appears to be affected by sudden variations in the yield.

5. In all women investigated, the percentage of fat in the milk examined showed a rise between the first and the fourteenth days.

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