CXLIV. A STUDY OF THE ANTENATAL SECRETION OF THE HUMAN MAMMARY GLAND AND A COMPARISON BETWEEN THIS AND THE SECRETION OBTAINED DIRECTLY AFTER BIRTH.

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IN a fairly complete study already made by us on the composition of human milk obtained directly after parturition and during the later stages of lactation [Lowenfeld *et al.*, 1927; Widdows *et al.*, 1930; Widdows and Lowenfeld, 1933], certain facts of a rather unexpected nature with regard to its composition in the early stages after labour were reported.

It has been generally recognised that the secretory activity of the maternal mammary gland commences before the expulsion of the foetus. An opportunity was given us for the study of samples of antenatal secretions, and since as far as we could ascertain very little work had been done on this subject, it was decided to undertake an investigation, the results of which are recorded in the present paper.

Work has been done on the antenatal secretion of cows, and it should be emphasised that workers on this line have had the very great advantage of being able to study in the same animal the progressive effects of pregnancy on the composition of the secretion. In particular, the work of Houdet [1894], and later Eckles and Palmer [1916], Woodman and Hammond [1922; 1923], and Asdell [1925] is interesting in view of certain results obtained by us.

Woodman and Hammond, working with heifers, analysed the secretion at 15, 22 and 28 weeks' gestation, the secretion between these stages being removed at intervals but not analysed, while Asdell removed and analysed the secretion at intervals from the 4th week of gestation up to parturition (total number of weeks of gestation being 41), first taking samples biweekly and afterwards weekly. Woodman, Hammond and Asdell all arrived at very much the same conclusion.

Up to the 15th week they obtained a serous secretion containing all the constituents found in milk, but with only traces of fat, and with small amounts of lactose, caseinogen, globulin and albumin, the globulin predominating over the caseinogen and albumin. About halfway through pregnancy the character of the secretion changed and it became thick, viscid and honey-like, with a high content of solid, chiefly protein. The protein consisted almost entirely of globulin, no caseinogen at all being found by Woodman and Hammond, and only a very small amount by Asdell. Traces of lactose were present and a very small amount of fat, and, in fact, Woodman and Hammond looked upon the secretion as a very concentrated solution of globulin. At about the 28th to the 30th week this viscid secretion gave place to a milk-like fluid in relatively large quantity which contained appreciable percentages of the normal constituents

of colostrum. When the cow is milked up to parturition, as shown by Asdell, the colostrum milk closely follows the composition of the prepartum fluid which has been approximating to true milk.

If the viscid secretion is not removed, then the transition to the colostrum phase appears to be more gradual, and it is only at the time of parturition that the secretion assumes the character of normal colostrum with a high percentage of globulin.

These workers concluded that during the early months of pregnancy the secretory activity of the gland is present but is feeble. At about halfway through pregnancy, which appears to correspond to a definite stage in the development of the gland, the normal activity of the cells, which results in the production of the caseinogen, lactose and fat, seems to be inhibited. If the viscid secretion at this stage is removed, the normal activity of the gland is gradually resumed in the same way as frequent milking stimulates activity during normal lactation.

Outside the limits of normal lactation, globulin seems a characteristic constituent of the mammary secretion, the protein of the secretion at a certain stage consisting practically entirely of globulin.

A tentative suggestion is put forward by Asdell, as a result of this study, that the globulin is present in the mammary ducts as a result of the change from growth to secretion on the part of the mammary cells. If the mammary secretion is removed at this stage, and continually removed as pregnancy proceeds, the proportion of globulin rapidly decreases, while if the secretion is allowed to remain in the gland, the globulin percentage remains high up to the time of parturition, and in the colostrum milk immediately after it, and only acquires the percentage found in ordinary milk as the result of continuous removal of the milk after parturition.

Eccles and Palmer in their work on cows, concluded that when cows are milked up to the time of parturition, the colostrum milk follows closely the composition of the milk given before birth. As the cow approached parturition, these workers found a marked increment of the heat-coagulable proteins which reached their maximum in the first milk obtained after birth. They concluded from these results that the high content of heat-coagulable proteins was the chief, if not the only real effect of parturition on the milk. This does not seem to accord with Asdell's later work, and although these workers only milked continuously for a month before birth, and they were dealing with cows and not heifers, one would have expected a month's continuous milking to have reduced and not increased the heat coagulable-proteins. The secretion during labour was not investigated by these workers. In our work such a complete investigation as the above was not possible. The secretion investigated was that which could be obtained (*a*) once or twice from the same woman during the 2 months before parturition, but (*b*) more often single scanty samples obtained from different women during this period. In view of the results of Woodman, Hammond and Asdell, on cows, it was thought that although the period of study of the antenatal secretion would be more limited in our case, such an investigation would be interesting. It was hoped that similar and comparative results would be obtained for the last 2 months of pregnancy, so that what was experimentally proved in the case of cows for the very early secretion might be inferred to be true of women, where the difficulties of obtaining this secretion make experimental work on such samples impossible.

In this paper it will be seen that to a certain extent our results are comparable, but that there are certain points not in accord and which at present lack explanation.

Czerny and Keller [1925] point out that for the analysis of the secretions of the mammary gland before parturition, there are only the incomplete analyses of Clemm [1845], whose figures are referred to by Engel [1911]¹. The figures obtained from the table in Engel's paper are the results of six analyses from the secretion of one woman. The figures obtained from such a method of investigation taken in conjunction with the probably less accurate methods of investigation available at this early date afford little material for comparison.

METHODS AND OBSERVATIONS.

The material for our work has been obtained from cases both primiparae and multiparae in the Maternity Department of the St Pancras Hospital and from the Shoreditch Carnegie Welfare Settlement.

In only a few cases has it been possible to deal with the same woman throughout the antenatal course, but the secretions from a large number of different cases have been studied, extending over a period from 2 months to the day of delivery. It is felt that to a large extent individual differences may be eliminated in this way and some generalisations may be drawn.

Cases investigated—total number 53.

1. Cases where specimens were obtained only before labour:

- (a) 26 cases where a single specimen was obtained;
- (b) one case where two specimens were obtained.

2. Cases where specimens were obtained both before and after labour:

- (a) 16 cases (including 4 cases in labour) from whom a single specimen was obtained before labour;
- (b) 10 cases from whom more than one specimen was obtained before labour, giving in all 34 specimens distributed as follows:

6 cases gave	2 specimens
1 case gave	3 „
1 „	4 „
1 „	5 „
1 „	10 „

3. These cases gave a total number of 78 specimens examined before labour.

The chemical constituents estimated were protein, ash, sugar, calcium, phosphorus and chlorine.

The methods employed in the estimations were those recorded in our earlier papers on milk [Lowenfeld *et al.*, 1927; Widdows *et al.*, 1930].

A. *Physical properties of the secretions studied.*

An examination of the mammary secretion before and after labour shows marked differences in its physical properties.

1. *Volume.* In the case of multiparae, after the first day after parturition the volume of the fluid obtained was found to vary from 10 to 30 ml., and in one woman (J.) investigated on the second day the volume obtained was as much as 90 ml. In the case of primiparae, the volumes were found to vary considerably, and sometimes for the first few days after birth were noticeably small.

¹ So far it has not been possible to obtain a paper by Guiraud [1897] in which all the early work on colostrum up to 1897 is collected including the figures of Clemm.

With very few exceptions, large volumes were not found to be obtainable before labour. Of the 64 women investigated, 9 specimens had a volume under 2 ml., 39 between 2 and 3 ml., 10 between 4 and 6 ml., and 6 between 6.5 and 7.5 ml. Occasionally an exception occurred—for instance, a multipara (H.) gave a volume of 22.5 ml. 2 weeks before labour, and another, a primipara (Ha.) gave, 5 weeks before labour, a volume of 38 ml. In two other cases a volume of 11 ml. has been obtained.

This great difference with regard to volume naturally suggests that the early secretion may merely be a concentrated form of later milk, and upon the elucidation of this point the interest of an investigation of the antenatal secretion depends. If the relative values of the different constituents of the gland are found to be approximately similar on both sides of the line of labour, then we are dealing with a physical change only, and the type of secretory activity is identical before and after labour.

A glance at the tables given below for sugar and calcium, compared with those for protein and ash, shows immediately that this is not the case. Each of the calcium and the sugar curves from 30 days before to 10 days after labour shows a fairly steep rise, settling down later to a more or less even value. In contrast with these curves, the protein values of the antenatal secretions never fall below 2.69 %, with an average of 8.9 %, and from these high values the curve declines steadily during the 10 days after parturition to 1.5 %, above which its value never rises (as shown in our paper on later milk [Widdows *et al.*, 1930]). It is clear therefore that the differences that occur between the fluid obtained from the mammary gland before and after labour must be due to a difference in the secretory activity of the gland and not merely to the variation of the water content in an otherwise standard fluid. For instance, one example (F.), 4 days after parturition gave a protein value of 1.62 % and at the same time 0.042 % CaO, 6.43 % sugar, and 0.28 % ash. The antenatal secretion 9 days before birth gave a protein value of 9.14 %, which on the assumption that there is merely a variation in the water content of the secretion should have given for CaO 0.238 %, for sugar 36.27 %, and for ash 1.57 %, whereas the percentages actually found were 0.0443 % CaO, 4.72 % sugar, and 0.56 % ash.

In view of the results obtained by Woodman, Hammond and Asdell on heifers and cows, it is possible that the explanation lies in the fact that the fluid before parturition in women is not removed from the breast.

2. *Colour and viscosity.* It is well known that the general physical properties of colostrum and early milk are different from those of later milk, and attention has been drawn to this point in our paper on early milk [Lowenfeld *et al.*, 1927]. The antenatal secretion seems to fall into three classes:

(1) A beige-coloured watery secretion, with fat globules sometimes separate from the watery fluid.

(2) An opalescent milky-looking fluid, much more viscid than the fluid described in (1).

(3) A secretion creamy and thick, sometimes very yellow, very viscid and sometimes appearing almost gelatinous.

The larger number of antenatal secretions examined belong to classes (2) and (3), and of these by far the larger number belong to class (2). Both these solutions coagulate on heating.

Engel [1911] in a paper on the biochemistry of cows' colostrum, in a short paragraph on the antenatal secretion, points out that Houdet [1894] had found similarly in cows two types of secretion, a viscid and a more fluid form, but

he had not been able to say at what stages in the pregnancy these two different types were produced.

Woodman, Hammond and Asdell, on the other hand, as shown above, associate the three degrees of viscosity with distinct periods of lactation, the very viscid (class 3) corresponding to the secretion obtained halfway through pregnancy.

All our samples fall within the last 2 months of pregnancy. It is therefore possible that the viscosities obtained by us may be very much less than would be shown by the secretion if we could obtain a specimen at about 5 months before birth. All three different types of secretion as regards viscosity, both in multiparae and primiparae, appear during the last 2 months of pregnancy, and at all times, varying from the day before to 2 months before birth. At present it does not seem possible to correlate these three types of secretion either with the stage of gestation or with a condition depending on the number of children borne. Some correlation seems, however, to be indicated between the chemical findings and the physical condition. This point will be referred to in connection with the different constituents of the secretion studied.

B. Chemical results.

Protein. Protein analyses were made on specimens from 48 women, 8 women giving specimens on more than one day, 35 giving one specimen only, and 5 giving specimens in labour or on the day of labour.

Table I. *Protein (g. per 100 ml.).*

P = primiparae, M = multiparae, L = lowest, H = highest.

Before birth								
	Weeks 8, 7, 6, 5	Weeks 4-3	Day 21-15	Day 14-8	Day 7-2	Day before labour	In labour	
P	L 2.69	L 4.54	L 6.06	L 5.90	L 4.12	L 5.49	L 9.864	
	H 8.97	H 17.5	H 8.64	H 11.09	H 13.46	H 6.43	H 17.34	
M	L 5.36	L 5.17	L 5.74	L 3.94	L 3.89	L 4.24	L 10.87	
	H 11.99	H 10.32	H 16.0	H 9.14	H 12.26	H 19.4	H 12.31	
Average values P + M (bracketed figures = no. of samples analysed).								
	8.40 (15)	9.28 (8)	9.18 (7)	7.54 (8)	8.16 (16)	8.385 (11)	12.598 (4)	
After birth								
Days ...	1st	2nd	3rd	4th	5th	6th	7th	8th
P	L 4.58	L 2.25	L 1.36	L 1.23	L 1.27	L 1.26	L 1.29	L 0.855
	H 14.1	H 8.34	H 8.47	H 3.66	H 2.34	H 1.76	H 1.96	H 1.94
M	L 2.64	L 1.64	L 1.59	L 1.51	L 1.54	L 1.3	L 1.14	L 1.07
	H 13.61	H 8.71	H 3.38	H 2.55	H 1.75	H 1.78	H 1.77	H 1.92
Average values P + M (bracketed figures = no. of samples analysed).								
	7.864 (11)	4.599 (17)	2.80 (27)	1.895 (25)	1.704 (20)	1.575 (20)	1.55 (13)	1.55 (23)

The figures for the percentage of protein of the antenatal secretion are compared with those of the protein of the milk obtained from 40 women during the 10 days after labour. 156 samples of the postnatal milk were analysed. The comparison is not made with later milk, as the comparison between the milk during the early and later days of lactation has already been recorded [Widdows *et al.*, 1930].

In our earlier work [Lowenfeld *et al.*, 1927], it was suggested that a significant difference was to be found in the protein values of the early days of lactation between multiparae and primiparae.

Fig. 1a.

Fig. 1b.

Fig. 1. • Represent percentages where no antenatal specimens were obtained. For clearness here percentages from same woman at different periods are not connected. ○ Represents percentages where both ante- and post-natal specimens were obtained. These are joined where more than one specimen from same woman was available, the connecting line being broken during periods when there were no specimens.

If the post-labour curves in the figures be considered, this suggestion that on the whole the milk of the primiparae tends to give much higher protein values than that of the multiparae on the 1st day after labour is reasonably borne out. It will be noticed that not only on the 1st day do the protein values tend to be higher, but even on the 3rd day after labour there are several values in the case of the primiparae over 6 %, whereas there are none in the case of the

multiparae. On the other hand, when the values for the antenatal milk are considered, very little reliable difference can be observed between the two series of curves. This may be due (a) to the absence of antenatal figures in so many of the primiparae mothers who give protein values of above 5 % on the 1st to the 5th day after labour and (b) to the fact that the cases represented in the multiparae table show a greater number in whom it was possible to make a series of consistent observations throughout the ante- and post-natal periods.

These differences have arisen out of practical circumstances in the cases studied. In our early work the postnatal cases were obtained largely from the wards of the Obstetric Unit of the Royal Free Hospital, and as is always the case with wards of this nature, there is a heavy preponderance of primiparae in their admissions. On the other hand, the antenatal cases were studied in connection with the St Pancras Hospital, where the larger proportion of cases admitted, either as in- or out-patients of the maternity department, are multiparae, whether married or single. To decide definitely whether, as first suggested, there is any real difference between the antenatal protein values of the primiparae and the multiparae will only be possible when a large number of primiparae can be studied throughout pregnancy.

From a study of the graphs of the cases so far examined, the following facts can be ascertained.

(1) In all cases, without exception, the protein value for the antenatal secretion is higher than it is in that obtained after labour. In the secretion actually obtained in labour, in the few cases examined, the value is very high, in one case reaching the astonishing value of 17·2.

(2) The protein value for both multiparae and primiparae falls steeply during the first days after lactation, the fall, as far as our figures show being very much steeper in the case of multiparae than in that of primiparae. In the case of multiparae with a single exception, all samples were below 3 % by the 3rd day, while in the primiparae they did not reach this level till the 6th day. With only one exception, by the 3rd day all values obtained were below 2·5 % for multiparae but values above 3 % were still found on the 4th day in the case of the primiparae.

(3) One of the characteristic features obtained from a study of the curves shown equally in primiparae and multiparae, is the very great degree of variation in the protein values found in specimens of the antenatal secretion. No explanation has been found for these differences. Clemm seems to have found a similar variation in his antenatal protein results, as with the same woman on two different occasions 4 weeks before birth, he gives the percentages 2·9814 and 6·9033 respectively.

(4) The protein values appear to fall to a certain extent into two groups related to a line drawn across the curves in the neighbourhood of the value 7 %. Approximately half of the specimens examined appear to fall into a group with percentages above this level, and half below.

This tendency to fall into a group of high or low values is borne out in other constituents, but we have not as yet any suggestion to make as to the possible factors responsible for this.

Houdet [1894] in the case of cows showed that the viscid secretion gave a very high protein percentage and the more liquid secretion a low percentage. In our results practically all the very high protein percentages, those over 10 %, both in the case of the primiparae and the multiparae, are obtained from secretions class (3) which were very viscid, while the low percentages, those below 6 %, were obtained from very watery thin secretions class (1). The per-

centages varying from 6 to 10 % were obtained from the creamy and viscid class (2).

There are, however, exceptions to the above generalisations. For instance, in one case a secretion creamy and viscid (class 2) gave a protein percentage of 12.6 %, and another of the same consistency 12.3 %—the latter was, however, a specimen taken in labour which, as indicated by results obtained in these cases, always seems to raise the protein value. In one or two cases where the secretion was rather viscid, low protein values were obtained—*viz.* about 6 %.

A point of interest which so far we have had no opportunity of investigating, but which we hope to investigate in the future, is the type of the protein in both the antenatal and postnatal secretions.

The protein in the colostrum of cows has been investigated by, among others, Sebelien [1885], Emmerling [1888], Engel [1911], Winterstein and Strickler [1906], Southerst [1902], and Tiemann [1898] and in the antenatal secretion by Woodman and Hammond [1922; 1923], and Asdell [1925]; in human colostrum by Camerer and Söldner [1896], Birk [1910], Meigs and Marsh [1913; 1914], Pfaundler [1915], and Lowenfeld *et al.* [1927], and in the antenatal secretion by Clemm, but only so far as total protein is concerned. Czerny and Keller [1925] sum up the results on both human and cows' colostrum by stating that the "insoluble" globulin was 2–4 times, and the total "insoluble" protein 10–30 times, more concentrated than in milk.

Woodman and Hammond and Asdell show that in the case of the cow the high percentage of protein is due largely to the globulin produced at about the 5th month of pregnancy, which does not disappear from the gland until the milk is regularly removed after parturition, although the secretion of all the constituents of true milk has been taking place for some weeks.

We have noticed that all specimens of the antenatal secretion give a very deep orange colour with concentrated nitric acid, and the same colour is given by specimens on the 1st and 2nd days after parturition. From the 2nd day onwards only a very pale yellow colour is given by the milk analysed. This characteristic, combined with the fact that the secretion gives a very heavy precipitate with dilute acid, and coagulates easily on heating, may possibly be due to a high globulin content.

It is thought that it is the phenyl group in the protein which gives the deep colour with nitric acid, and from the table given by Lloyd [1926, p. 46] it will be seen that globulin contains a high percentage of the constituents containing this group. If the colour reaction with nitric acid is due to the preponderance of globulin in the antenatal secretion as well as that immediately after birth, it would seem that there is a very quick diminution of this protein with the withdrawal of the secretion after birth, as the deep orange colour disappears so rapidly.

A breast that has not had a period of lactation does not secrete as readily as one that has already done so, and it is unlikely that there will be any leakage of the secretion before parturition. From a comparison with the work on cows, it seems probable that the secretory activity of the gland in the case of the primiparae would not be as advanced as in many cases of the multiparae where stimulation to increased secretory activity would be induced by leakage. One would thus expect in the majority of cases of primiparae to find a high percentage of globulin as compared with cases of multiparae, and a smaller proportion of the constituents of normal milk both before and for a longer time after birth.

The type of protein occurring in the antenatal secretion and that immediately after birth is a point that requires investigation, but the great difficulty

in attacking this problem lies in the inability to obtain sufficient of the secretion for analysis.

Sugar. The antenatal secretion was examined for sugar in 67 samples from 43 women. The number of cases whose secretion was examined on more than one day was 10, on one day only 30 and in labour 3. Between the 1st and 10th days after labour, 244 samples were analysed. In contrast to the ash and protein, as seen in the table and by the graph, the percentage of sugar is low before labour and rises very rapidly during the first days after labour. A low percentage before labour was to be expected from our earlier work [Widdows *et al.*, 1930], where it was shown that the sugar percentage was at its lowest in early milk, but had risen by the end of the 1st month to an average of a little over 7 %, from which there was little material alteration throughout the whole subsequent course of lactation. There seems to be no significant difference in the sugar values of the primiparae and multiparae. The lowest value obtained before labour was 1.1 % and the highest 4.72 %, but the usual value was between 2.5 and 3.9 %. On the 3rd day after labour, the average value in the case of both primiparae and multiparae had risen to over 6 %. In the three cases examined during labour, in the two primiparae there was a very low sugar percentage, while in that of the multipara it was high, slightly higher than the average for the six samples taken the day before labour. Whether there is really any significant difference here can only be determined by the analysis of a great many more samples, but as the difficulty of obtaining

Table II. *Sugar: average values (g. per 100 ml.).*

Before birth								
	Weeks 9, 8, 7, 6	Weeks 4-3	Days 21-15	Days 14-8	Days 7-2	Day before labour	In labour	
P	3.243 (7)	3.59 (4)	3.05 (5)	3.16 (3)	2.832 (6)	3.498 (4)	0.83 (2)	
	L 2.90	L 3.28	L 2.01	L 2.74	L 1.58	L 3.26	L 0.70	
	H 3.74	H 3.89	H 3.9	H 3.76	H 3.84	H 3.84	H 0.97	
M	2.79 (6)	3.94 (3)	2.44 (4)	3.94 (5)	3.13 (10)	2.76 (6)	3.165 (1)	
	L 1.78	L 3.65	L 1.76	L 2.76	L 1.10	L 2.06	—	
	H 3.54	H 4.22	H 3.58	H 4.72	H 4.12	H 3.14	—	
P + M	3.033 (13)	3.741 (7)	2.78 (9)	3.645 (8)	3.02 (16)	3.054 (10)	1.110 (3)	
	L 1.78	L 3.28	L 1.76	L 2.74	L 1.1	L 2.06	L 0.70	
	H 3.74	H 4.22	H 3.9	H 4.72	H 4.12	H 3.84	H 3.165	
After birth								
Days ...	1st	2nd	3rd	4th	5th	6th	7th	8th, 9th and 10th
P	2.86 (8)	4.68 (17)	6.22 (16)	6.67 (19)	6.95 (15)	7.175 (15)	7.02 (11)	7.27 (19)
	L 1.08	L 2.61	L 3.55	L 6.67	L 5.38	L 6.11	L 6.53	L 5.67
	H 4.7	H 6.4	H 7.77	H 7.69	H 7.58	H 8.36	H 7.14	H 8.27
M	3.58 (6)	4.37 (20)	6.396 (21)	6.68 (19)	6.92 (13)	7.02 (13)	7.35 (11)	7.33 (20)
	L 2.46	L 1.49	L 4.65	L 4.98	L 4.77	L 5.97	L 6.66	L 6.00
	H 6.26	H 6.9	H 7.4	H 7.64	H 7.87	H 7.78	H 7.76	H 8.10
P + M	3.17 (14)	4.51 (37)	6.32 (37)	6.67 (38)	6.94 (28)	7.10 (28)	7.18 (22)	7.30 (39)
	L 1.08	L 1.49	L 3.55	L 4.98	L 4.77	L 5.97	L 6.53	L 5.67
	H 6.26	H 6.9	H 7.77	H 7.69	H 7.87	H 8.36	H 7.76	H 8.27

such samples is evident, the authors felt it was of interest to record these results.

There is, however, this point to notice, that in the case of the multipara G. the sample analysed was taken about 7 hours before the birth of the child, while in the case of both of the primiparae, the sample was taken at an earlier stage in labour. One, W., was taken at the beginning of labour where the labour lasted 2 days, and the other J. was taken between 16–17 hours before the birth of the child. Whether in the case of the multipara the value of the sugar percentage was lower at the beginning of labour, and at the time of taking was beginning to rise as it always does directly after labour, or whether there is really a difference between the primiparae and multiparae can only be decided by further work. In no case yet have we been able to make a consecutive series of analyses beginning a few days before and continued through labour to a few days after labour. Only from such analyses could any definite conclusions be drawn.

On considering the highest and lowest values in the average of percentage for sugar for the different periods, in Table II it will be seen that the primiparae and multiparae seem to divide themselves into two groups as in the case of protein and ash, (1) those starting with a percentage of sugar before labour of 2 % and rising during the second week after labour to 6 %; (2) those starting before labour with a percentage of about 3·8 % and rising in the same period after labour to 8 %. The quicker rise to a higher figure after labour is more manifest in the groups starting with higher sugar before labour.

On examining the different classes of fluid, it was found that the percentage of sugar for the very viscid class 3 (20), the opalescent and viscid milky fluid class 2 (43), the watery secretion class 1 (14) gave respectively average values of 2·717, 3·45 and 3·585 g. Although the highest individual value 5·02 % was found among the less viscid type class 2, yet in the case of the watery secretion the values, except in one case, were all well over 3 % and in some cases over 4 %, the lowest being 2·79 %. In the other types of secretion there were many values between 2 and 3 %.

Ash. The antenatal secretion of 50 women has been examined for ash. A sample on more than one day was obtained from 9 women and on one day only from 36 women. Five samples were obtained during labour.

There is no significant difference to be observed between the multiparae and the primiparae.

The ash percentage is consistently high throughout the antenatal period. Out of 74 samples analysed, only in two instances did it fall below 0·3 %. The majority of cases give a percentage between 0·5 and 0·68, except in two samples from one particular patient on two consecutive days when the percentage obtained was 0·8. In the five cases in labour the percentage is over 0·6.

After labour there is a steady decline in the percentage of the ash from over 0·5 % on the 1st day to between 0·2 and 0·3 % after the 1st week.

The specimens from both the primiparae and the multiparae seem to fall into two groups:

(1) Those starting in the antenatal period at 0·5 % and declining gradually to 0·16 % 10 days after labour.

(2) Those starting about 0·68 % and gradually declining in the same period of time to about 0·34 %.

The graphs for ash and protein run almost parallel. The graphs show rather irregular figures before labour, falling gradually but persistently after labour to a more or less constant level.

Table III. *Ash: Average values in g. per 100 ml.*

Before birth								
	Weeks 8, 7, 6, 5	Weeks 4-3	Days 21-15	Days 15-8	Days 7-2	Day before labour	In labour	
P	0.54 (8)	0.53 (4)	0.511 (6)	0.675 (4)	0.556 (5)	0.475 (4)	0.70 (3)	
	L 0.5 H 0.6	L 0.44 H 0.60	L 0.31 H 0.64	L 0.52 H 0.80	L 0.40 H 0.66	L 0.39 H 0.62	L 0.68 H 0.74	
M	0.57 (8)	0.38 (3)	0.56 (3)	0.49 (6)	0.535 (9)	0.565 (7)	0.62 (2)	
	L 0.48 H 0.68	L 0.28 H 0.52	L 0.52 H 0.60	L 0.28 H 0.56	L 0.30 H 0.60	L 0.40 H 0.60	L 0.62 H 0.62	
P + M	0.55 (17)	0.46 (7)	0.53 (9)	0.566 (10)	0.543 (14)	0.532 (11)	0.668 (5)	
	L 0.48 H 0.68	L 0.28 H 0.60	L 0.31 H 0.64	L 0.28 H 0.80	L 0.30 H 0.66	L 0.39 H 0.62	L 0.62 H 0.74	
After birth								
Days ...	1st	2nd	3rd	4th	5th	6th	7th	8th, 9th and 10th
P	0.59 (5)	0.365 (7)	0.34 (12)	0.325 (18)	0.29 (13)	0.28 (14)	0.26 (12)	0.257 (24)
	L 0.50 H 0.72	L 0.26 H 0.60	L 0.24 H 0.66	L 0.22 H 0.44	L 0.23 H 0.36	L 0.17 H 0.42	L 0.14 H 0.38	L 0.16 H 0.34
M	0.53 (6)	0.39 (9)	0.32 (14)	0.31 (11)	0.29 (10)	0.27 (12)	0.265 (11)	0.259 (22)
	L 0.40 H 0.62	L 0.29 H 0.64	L 0.20 H 0.46	L 0.20 H 0.54	L 0.20 H 0.38	L 0.20 H 0.42	L 0.16 H 0.38	L 0.16 H 0.33
P + M	0.556 (11)	0.382 (16)	0.33 (26)	0.32 (29)	0.29 (23)	0.275 (26)	0.264 (23)	0.258 (46)
	L 0.40 H 0.72	L 0.26 H 0.64	L 0.20 H 0.66	L 0.20 H 0.54	L 0.20 H 0.38	L 0.17 H 0.42	L 0.14 H 0.38	L 0.16 H 0.34

Fig. 2.

As regards the relation of the ash content to the physical properties of the secretion, in the case of cows, Houdet, according to Engel [1911], found that in the viscid secretion there were only traces of salts and in the more fluid about 0.36 %.

In the case of the human secretion, a study of our figures does not seem to show any striking connection between the three classes of fluid and the ash values found. In the very viscid fluids (20) class 3, there was only one example giving a low ash 0.3 %, in the less viscid secretion (46) class 2 and the watery secretion (15) class 1 both high and low values occurred, the high values largely preponderating in both. The averages for the three types respectively were 0.586, 0.518 and 0.49 %. The high or low values do not seem to occur at any definite time during the antenatal period, both high and low values are found at all times from 8 weeks before and up to the day of birth, although at all periods the high values largely predominate.

Calcium. Calcium has been investigated in the antenatal secretion of 49 women, in 36 cases on one day only, 9 on more than one day and 4 in labour, 74 samples in all having been analysed. The results so obtained are compared with those obtained from the secretion during the 10 days immediately after labour, of which 215 examples were examined.

On the whole the percentage of calcium in the antenatal secretion is low, although occasionally a high value is obtained. In the few specimens obtained during labour, the average shows a decrease in the percentage at this time, rising immediately after labour and continuing to rise gradually during the next 10 days.

It has been shown already [Widdows *et al.*, 1930] that the calcium value rises gradually to a maximum during the first 4 months after birth, and then falls very slowly during the 5th to the 7th months, and more rapidly from the 7th to the 10th months.

We have in our earlier work on two occasions [Lowenfeld *et al.* 1927; Widdows *et al.*, 1930] in agreement with other workers [Hunaeus, 1909; Bahrt and Edelstein, 1910] emphasised the fact that the differences between individuals in the calcium content of the milk are much greater than the variations from day to day in any one individual.

This makes the interpretation of results difficult where only a few samples of the secretion can be obtained, and where it is not possible in the same women to obtain samples for the few days consecutively before and after the period in question, as for example, in the cases of samples obtained from women in labour.

From Table IV it will be seen that in the primiparae the average percentage of calcium oxide the day before labour is 0.0366, during labour 0.0305, and on the 2nd day after labour 0.0376. Only three samples were obtained during labour, two from the same woman gave low calcium oxide values of 0.0254 and 0.0264 %, whilst the one from the other gave higher values of 0.0396 %. Four samples were obtained on the day before labour but from different women from those in labour. One gave a high value for the calcium oxide 0.0548 %, higher than the highest value during labour, 0.0396 %, and the others the low values of 0.0272, 0.033 and 0.0311 %. The lowest value before labour, 0.0272 %, is also higher than either of the low values 0.0254 and 0.0264 % during labour.

In the case of the multiparae, where the secretion was examined in the case of only two women during labour, the percentage of calcium oxide in one sample was 0.0258 g., and in the other 0.0234 g. both low values, but in the seven samples the day before birth the highest percentage of calcium oxide in one sample was 0.041 g. and the lowest 0.0224 g. Here also the highest value before labour, 0.041 g., is higher than the highest value during labour, 0.0258 g., on the other hand, the lowest value before labour, 0.0224 g., is lower than that of the lowest

value, 0.0234 g., during labour. Again, these values were not those of samples taken from the same women as those whose samples were taken in labour, and the value 0.0224 g. was the only one out of seven lower than the value in labour, 0.0234 g.

In these circumstances, the average values are probably a better criterion of the relative changes occurring throughout the ante- and post-natal periods studied.

From our work on milk in the early and later days of lactation it was realised that some women throughout lactation had consistently a higher calcium value for their milk than others, and it was therefore not surprising to find that this was also the case in the antenatal secretion. For instance, in one case M. where in the antenatal period 10 days before birth four samples were taken, the calcium oxide percentage varied between 0.027 g. and 0.025 g., in the postnatal period the value gradually rose to 0.0388 g., whereas in another case R., where

Table IV (a).

Calcium oxide.

Average values—g. per 100 ml.

A. Before birth.

	Weeks 8, 7, 6, 5	Weeks 4-3	Days 21-15	Days 14-8	Days 7-2	Day before labour	In labour
P	0.030 (8)	0.0347 (5)	0.024 (6)	0.0285 (4)	0.0326 (5)	0.0366 (4)	0.0305 (3)
	L 0.013	L 0.26	L 0.0198	L 0.026	L 0.022	L 0.0272	L 0.0254
	H 0.043	H 0.042	H 0.031	H 0.033	H 0.055	H 0.0548	H 0.0396
M	0.0294 (8)	0.035 (3)	0.0398 (3)	0.030 (6)	0.031 (9)	0.030 (7)	0.0246 (2)
	L 0.0197	L 0.031	L 0.025	L 0.025	L 0.0235	L 0.0224	L 0.0234
	H 0.034	H 0.0395	H 0.045	H 0.044	H 0.042	H 0.041	H 0.0258
P + M	0.030 (17)	0.035 (8)	0.0293 (9)	0.0298 (10)	0.0305 (14)	0.0325 (11)	0.0281 (5)
	L 0.013	L 0.026	L 0.0198	L 0.025	L 0.022	L 0.022	L 0.0234
	H 0.043	H 0.042	H 0.045	H 0.044	H 0.055	H 0.054	H 0.0396

Phosphorus pentoxide.

Average values—g. per 100 ml.

P	0.0074 (6)	0.0143 (1)	0.0169 (2)	0.0128 (2)	0.0187 (4)	—
	L 0.005	—	L 0.011	L 0.0119	L 0.0146	—
	H 0.0119	—	H 0.0229	H 0.0137	H 0.0204	—
M	0.0189 (3)	0.020 (2)	—	0.0138 (4)	0.0119 (5)	0.01422 (5)
	L 0.0133	L 0.0172	—	L 0.0111	L 0.0078	L 0.0114
	H 0.0292	H 0.023	—	H 0.0143	H 0.014	H 0.0153
P + M	0.0118 (10)	0.0181 (3)	0.0169 (2)	0.0132 (6)	0.0149 (9)	0.0142 (5)
	L 0.005	L 0.0143	L 0.011	L 0.0111	L 0.0078	L 0.0114
	H 0.0292	H 0.023	H 0.0229	H 0.0143	H 0.0204	H 0.0153

Calcium oxide
Phosphorus pentoxide ratio.

3.21 (10)	2.1 (3)	1.54 (2)	2.41 (8)	2.2 (8)	2.08 (5)
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Average ratio for 4 weeks before birth = 2.17.

Table IV (*b*).*Calcium oxide.*

Average values—g. per 100 ml.

B. After birth.

Days...	1st	2nd	3rd	4th	5th	6th	7th	8th, 9th, and 10th
P	0.0284 (5)	0.0376 (10)	0.039 (15)	0.041 (18)	0.0436 (11)	0.042 (14)	0.041 (11)	0.041 (34)
	L 0.025 H 0.034	L 0.020 H 0.062	L 0.025 H 0.049	L 0.030 H 0.069	L 0.033 H 0.054	L 0.032 H 0.049	L 0.032 H 0.059	L 0.025 H 0.069
M	0.035 (7)	0.0359 (9)	0.041 (15)	0.0416 (14)	0.042 (11)	0.044 (11)	0.0397 (10)	0.0395 (19)
	L 0.023 H 0.046	L 0.024 H 0.054	L 0.021 H 0.059	L 0.023 H 0.048	L 0.029 H 0.064	L 0.034 H 0.059	L 0.034 H 0.045	L 0.0245 H 0.050
P + M	0.0323 (12)	0.0368 (19)	0.0398 (30)	0.0414 (32)	0.042 (22)	0.0425 (26)	0.041 (21)	0.041 (53)
	L 0.023 H 0.046	L 0.020 H 0.062	L 0.021 H 0.059	L 0.023 H 0.069	L 0.029 H 0.064	L 0.032 H 0.059	L 0.032 H 0.059	L 0.0245 H 0.069

Phosphorus pentoxide.

Average values—g. per 100 ml.

P	0.0215 (2)	0.0212 (6)	0.0252 (6)	0.0276 (8)	0.0377 (7)	0.0376 (7)	0.0365 (7)	0.0377 (27)
	L 0.0204 H 0.0227	L 0.0145 H 0.0263	L 0.0145 H 0.0355	L 0.0189 H 0.0355	L 0.0229 H 0.0475	L 0.027 H 0.043	L 0.0332 H 0.0437	L 0.0251 H 0.056
M	0.0265 (2)	0.0265 (5)	0.030 (9)	0.031 (11)	0.0339 (9)	0.0392 (7)	0.0371 (8)	0.0408 (12)
	L 0.0145 H 0.0387	L 0.0183 H 0.0356	L 0.0129 H 0.0424	L 0.0138 H 0.045	L 0.0189 H 0.0475	L 0.0297 H 0.0504	L 0.0229 H 0.0504	L 0.0306 H 0.0504
P + M	0.024 (4)	0.0236 (11)	0.0281 (15)	0.0296 (19)	0.0356 (16)	0.0384 (14)	0.0368 (14)	0.0384 (39)
	L 0.0145 H 0.0387	L 0.0145 H 0.035	L 0.0129 H 0.0424	L 0.0189 H 0.045	L 0.0189 H 0.0475	L 0.027 H 0.0504	L 0.0229 H 0.0504	L 0.0251 H 0.056

Calcium oxide

Phosphorus pentoxide ratio.

1.4 (3)	1.32 (3)	1.59 (13)	1.45 (14)	1.23 (9)	1.01 (10)	0.99 (12)	1.36 (21)
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Average ratio for first 7 days = 1.27.

three samples were obtained, one a month, one 3 weeks and one 4 days before birth, the values were over 0.04 %, and they remained high after birth, rising on the 4th day after labour to 0.048 %.

From these average values, it is concluded (*a*) that the calcium percentage in the secretion before birth rarely rises to much over 0.03, and in many cases is much less, and (*b*) that it is at its lowest value during labour and steadily rises after labour towards its maximum.

There does not appear to be any difference in the calcium values in the cases of the primiparae and the multiparae.

Phosphorus. The antenatal mammary secretions of 27 women were examined for phosphorus, and 34 samples were analysed, of which 23 represented single specimens from 23 different women and 11 were samples from 4 women, one providing 4, one 3, and two 2 samples on different days. 132 samples of milk from the 1st to the 10th day after birth were analysed, and the results compared with those obtained from the antenatal secretion.

The percentage of phosphorus in the secretion is very low throughout the antenatal period studied, but begins to rise immediately after labour. It has been previously shown that the maximum value for the phosphorus pentoxide percentage is not realised till the end of the 4th month after parturition. Before birth, the highest percentage of phosphorus pentoxide, except in one case of a multipara giving 0.029, is only just over 0.02, and in many cases the percentage is much lower.

Fig. 3.

Ca/P ratio. On examining the graphs for calcium oxide and phosphorus pentoxide at the different stages both before and after labour, it will be seen that they follow each other very closely, the phosphorus values being at a much lower level before birth than those of the calcium. In the case of the calcium oxide the average percentage before parturition is over 0.03 or approximating to it, the highest value for each period being over 0.04, while, as stated above, in only one case does the value rise to 0.029 in the case of the phosphorus pentoxide. After birth too the average value for the calcium oxide percentage has risen to over 0.04 on the 4th day, while in the case of the phosphorus pentoxide, on the 10th day the value is still lower than that of the calcium.

Schlossmann [1904] thought that a high protein value was associated with a high phosphorus value, but our work does not seem to support this view. Our protein values are highest before and just after birth, while our phosphorus values are low during all these periods.

In our work on later milk it was shown that the percentage of calcium oxide in milk throughout lactation was usually greater than that of phosphorus pentoxide, and that the average ratio of these percentages did not show a great variation. The average ratios during the periods 1-2 weeks, 1 month, 2-4 months and 5-10 months were 1.35, 1.34, 1.42, 1.25 respectively. The individual variations however were shown to be greater, varying from 0.81 to 2. McCollum *et al.* [1921] had pointed out the importance of this ratio, and in our paper [Widdows *et al.*, 1930] this ratio was discussed and an explanation suggested.

In the case of the antenatal secretion this ratio was also examined and as the percentage of phosphorus pentoxide before birth relative to that of calcium oxide was considerably lower than it is after birth, this ratio necessarily has a higher value. The average value for the ratio for the whole period from 8 weeks to the day before birth is 2.46 and for the different periods considered

the average ratio varied from 1.5 to 3.21. The average value for the first 7 days after birth is 1.27.

One would expect the ratio of calcium to phosphorus in the antenatal secretion to be different from, and more variable than, that in the milk after birth, partly on account of the fact that the secretion has no practical value as a food for the infant at that time, and also because the proportions of the calcium and the phosphorus present must depend on several factors. These factors are:

(1) The demand of the foetus for these elements at the stage of gestation under consideration.

(2) The necessity of a supply of these elements (which are constituents of normal milk) to the secretion gradually developing to form the fluid which is the perfect food for the newborn infant.

(3) The capacity of the blood supply of the mother to provide all the calcium and phosphorus required both for the foetus and the secretion without drawing unduly on her own reserves.

Since in our work we have only been able to study the composition of the secretion during the last 2 months before parturition, it will here only be possible to consider that period.

Bar [1907] had made an exhaustive study of the nutrition of the foetus during normal pregnancy. In this work he has shown that the need of the foetus for both phosphorus and calcium is usually very small during the first part of gestation but increases enormously during the last 2 months. During this latter period the foetus demands from the maternal organism 0.58 g. of phosphorus in the form of the pentoxide and 0.638 g. of calcium in the form of the oxide per day, while from the 4th to the 6th month only 0.046 g. of phosphorus pentoxide and 0.083 g. of calcium oxide are required per day. There is, therefore, a heavy drain on the mother by the foetus at this period for these two elements, so that the secretion developing to form the normal milk will only, one may suppose, obtain its necessary supply after the needs of the foetus are satisfied.

Both in the case of phosphorus and calcium there is a large retention towards the end of the pregnancy as shown by the decreased urinary output of these elements, although in the case of phosphorus Bar states that the proportion of organic phosphorus in the urine may be very slightly increased.

Since our ratio of calcium oxide to phosphorus pentoxide in the mammary secretion is higher before than it is after parturition, it is probable that there is more calcium relatively to phosphorus available for the secretion from the parent organism before than there is after birth.

Bar points out, from his work on dogs, that during gestation the mother can remove from the food the phosphorus elements necessary for the development of the foetus, and, provided the ration is sufficient, does not draw on her own capital of phosphorus.

He has also shown that phosphorus assimilation follows closely that of nitrogen. At the beginning of gestation there is a retention of both above the needs of the foetus, followed by a period of excretion probably due to the saturation of the organism by these elements. During the last weeks there is a very active retention to meet the heavy demands of the foetus.

In the case of nitrogen, throughout the whole of pregnancy, its assimilation seems to be good so that Bar remarks that in women in good health free to regulate their own diet it is common to observe a retention of nitrogen above that required for the foetus, its appendages, and the development of the uterus and the breasts, and that the nitrogen retained goes to increase the nitrogen

capital of the mother. Consequently pregnancy appears to be a period of gain of nitrogen to the maternal organism. This would account for the high nitrogen content of the mammary secretion both before and after parturition which has been emphasised in the preceding pages.

Bar showed also that although the assimilation of phosphorus follows the same course as that of nitrogen, its retention is by no means as good, and that there may be a gain of nitrogen where at the same time there is a loss of phosphorus.

Towards the end of its intra-uterine life, the demand of the foetus for phosphorus is greater than it is for nitrogen, but, in spite of this, in the ration absorbed the proportion of phosphorus may be small—further in the case of women Bar has observed that the utilisation of the absorbed phosphorus ration has been frankly mediocre. This he points out may be due among other things to the phosphorus being present largely in the inorganic form owing to an excess of mineral bases, and thus passing into the state where it is of no value for building up the tissues of the foetus.

It is evident from Bar's work that the parent organism will often have as much as it can do to supply the foetus at the end of gestation with its necessary phosphorus, and that therefore there can only be a small amount available for the mammary secretion that is forming. The fact that the phosphorus percentage in this secretion is low both before and immediately after parturition has perhaps here an explanation, especially as the women whose secretions were examined all came from the poorer classes where the food ration is likely to be poor in phosphorus.

In the case of the calcium Bar has shown that four-fifths of the calcium which the foetus contains at full term is acquired during the last 2 months of gestation. During the early part of pregnancy he has also shown that there is mobilisation of calcium, though this is not required by the foetus at that time. This is eliminated largely by the faeces and the urine, but at the end of gestation, when the needs of the foetus become intense, this elimination suddenly diminishes.

It appears from Bar's work that there is always calcium available during pregnancy, more than sufficient for the needs of the foetus, some always being derived from the maternal organism. It is therefore not surprising that the antenatal mammary secretion, as we have found, contains a larger percentage of calcium relative to that of the phosphorus than is found in the milk secreted normally after birth.

From a study of the calcium in blood of pregnant women, it has been shown by de Wesselow [1922] and Widdows [1923] that, in spite of the heavy demands made by the foetus during the last 2 months before birth, the blood tends to maintain a fairly constant value for calcium oxide, tending to decrease during the 8th and 9th months and to rise again immediately after parturition. Among other workers, Bar [1907] and Lamers [1912] found the blood calcium higher in pregnant than in non-pregnant women, Kehrler [1920] found it definitely low in pregnant women, and Jansen [1918, 1, 2] found it little altered. The above discrepancies may be in part accounted for by the fact that de Wesselow and Widdows analysed the serum and the other workers the whole blood.

In the case of the whole blood the calcium is not distributed evenly between the plasma and the corpuscles and so, unless the proportion of the corpuscles to plasma is ascertained, the true value for the calcium is not obtained. De Wesselow [1922] found also that in the case of phosphorus there was a tendency for its value to fall during the last 2 months of gestation, rising after parturition and during lactation to a figure definitely above that of the non-lactating female.

These facts bear out and we think explain the reasons for the calcium value of the antenatal mammary secretion being high relatively to the phosphorus before parturition.

Chlorine. No record has been given in any previous papers of our results on the percentage of chlorine either in early or late milk, although estimations have been made during these periods.

The method of estimation for the chlorine was that of Patterson [1928]. Our results on the whole agree with those of Sissons and Denis [1921] who have made a fairly comprehensive study of this element in postnatal milk. Our average for 80 samples taken from different women at all stages of lactation from 2 weeks to 42 weeks after birth is 32.1 mg. per 100 ml. of milk. The average given by Sissons and Denis is 38.1. These investigators found that in normal women after the 1st week of lactation there was a relatively narrow range of variation from 30 to 50 mg. of chlorine per 100 ml. of milk. We have found that the range in our cases was from 20 to 50 mg., that 25 % of our cases varied from 30 to 50 mg. and 48.75 % from 20 to 30 mg. Out of the 80 samples analysed we had only 10 over 50 mg. per ml. Sissons and Denis found that specimens of milk in which the chlorine concentration was over 50 mg. per ml. were from mothers who were giving an inadequate amount of milk for the growth of the infant. Our 10 cases where the percentage of chlorine was over 50 mg. per 100 ml. and not exceeding 58 mg. do not seem to support this contention, as in all cases, except one, the supply of milk was plentiful and the child was doing well. In

Table V. *Chlorine.*

Average values—g. per 100 ml.

Before birth								
	Weeks 8, 7, 6, 5	Weeks 4-3	Days 21-15	Days 14-8	Days 7-2	Day before labour	In labour	
P	0.1082 (8)	0.0868 (4)	0.1313 (5)	0.1240 (2)	0.1263 (6)	0.400 (3)	0.20 (1)	
	L 0.072	L 0.0236	L 0.0624	L 0.075	L 0.0588	L 0.072	—	
	H 0.152	H 0.127	H 0.163	H 0.173	H 0.186	H 0.153	—	
M	0.1414 (7)	0.0866 (3)	0.013 (2)	0.102 (4)	0.1349 (10)	0.1182 (7)	0.1644 (2)	
	L 0.0454	L 0.072	L 0.045	L 0.0776	L 0.0685	L 0.0936	L 0.133	
	H 0.276	H 0.103	H 0.181	H 0.161	H 0.210	H 0.1583	H 0.1958	
P + M	0.123 (16)	0.086 (8)	0.126 (7)	0.111 (6)	0.132 (16)	0.1128 (10)	0.1762 (3)	
	L 0.0454	L 0.0236	L 0.045	L 0.075	L 0.0588	L 0.072	L 0.20	
	H 0.276	H 0.127	H 0.180	H 0.173	H 0.210	H 0.158	H 0.133	
After birth								
Days...	1st	2nd	3rd	4th	5th	6th	7th	8th, 9th and 10th
P	0.11 (12)	0.1078 (16)	0.0743 (14)	0.0637 (22)	0.0543 (16)	0.0541 (17)	0.0558 (11)	0.0488 (32)
	L 0.058	L 0.0588	L 0.033	L 0.033	L 0.020	L 0.0169	L 0.023	L 0.0248
	H 0.2335	H 0.1875	H 0.1158	H 0.137	H 0.073	H 0.116	H 0.096	H 0.094
M	0.1289 (9)	0.0975 (24)	0.0755 (30)	0.0563 (22)	0.0498 (21)	0.0509 (18)	0.0510 (11)	0.0415 (35)
	L 0.060	L 0.0582	L 0.036	L 0.026	L 0.026	L 0.0248	L 0.0327	L 0.0291
	H 0.232	H 0.185	H 0.1440	H 0.0927	H 0.0927	H 0.077	H 0.0779	H 0.0685
P + M	0.1187 (21)	0.1016 (40)	0.0755 (44)	0.05997 (44)	0.0518 (37)	0.0525 (35)	0.0534 (22)	0.0436 (69)
	L 0.058	L 0.0582	L 0.033	L 0.026	L 0.020	L 0.0169	L 0.023	L 0.0248
	H 0.233	H 0.1874	H 0.144	H 0.137	H 0.092	H 0.116	H 0.096	H 0.094

this one case, as well as in one additional case where the content of chlorine was 72 mg. per 100 ml., it is true the supply of milk was scanty, but as, in both cases, artificial feeding had been adopted and the child was doing well, it is not possible to say whether these cases support the findings of Sissons and Denis.

It may be that where the milk is insufficient for the nourishment of the child the chlorine percentage may be high, but it does not seem that a content of chlorine over 50 mg. per 100 ml. is necessarily accompanied by a scanty supply of milk and an ill-nourished child.

We found, as did Sissons and Denis, extreme variations in the chlorine contents of specimens of milk collected from women in the same period of lactation. In the 4th week of lactation there was a variation from 23.9 mg. per 100 ml. to 52.2 mg. per 100 ml. and specimens with high and low contents were found to occur at all stages of lactation. In one case, a 4-week specimen gave 23.9 mg. per 100 ml. chlorine, and in another 52.2 mg. per 100 ml., while two 19-week specimens gave respectively 29.7 mg. and 42.2 mg. per 100 ml. It was noticed that only during the last weeks of lactation, with one exception, did the value even fall below 20 mg. per 100 ml.

There is a tendency for a high concentration of chlorine during the 1st week after birth. Sissons and Denis found that it varied from 158 mg. to 42 mg. per 100 ml. Our average variation, examined between the 1st and 7th days after parturition, was from 118 mg. to 51 mg. per 100 ml. for 243 specimens, and the average value for the 8th, 9th and 10th days from 69 samples was 43.6 mg. per 100 ml. Our percentages during this period varied from 233 mg. to 20 mg., one sample giving a value of 16.9 mg.

Sixty-three samples of antenatal secretion have been investigated for their chlorine contents. The percentage of chlorine is strikingly higher throughout the whole antenatal period examined, and seems to run parallel with that of the protein and ash.

The average given by the 63 samples is 118 mg. per 100 ml., the same as the average value found for the 1st day after labour. The range of values is from 276 mg. to 45 mg. per 100 ml. In the whole 63 samples there are only three, including one of a primipara in the 3rd to 4th week before birth giving 23.6 mg., which give a value for chlorine less than 50 mg. per 100 ml., and 57 % of the samples analysed gave over 100 mg. per 100 ml. Since the value for the percentage of chlorine is high immediately after birth, it was to be expected from analogy with the protein and ash values that the chlorine value before birth would also be high, and, as shown, this expectation was realised since both the average and individual values in the antenatal secretion are considerably above those found in the early postnatal milk.

Three specimens from women in labour were investigated and show a much higher chlorine value than the average for the day before or the day after birth. In the case of the primipara the value 200 mg. per 100 ml. in labour is above the values for all the three samples taken the day previous to birth, and in the case of the two multiparae the higher value is above the values for all the seven samples taken the day before birth, while the lower one is higher than five, equal to one and lower than one. The women giving the samples in labour are none of them women from whom samples had been obtained the day before birth.

The same extreme variations were noticed in the chlorine content of specimens of the antenatal secretion collected from different women at the same period of lactation as had already been noted in the cases during later lactation. There seems no significant difference between the results obtained from primiparae and multiparae.

The values for the chlorine in the antenatal period, as already noticed, are always high, but the highest values do not necessarily correspond to the highest ash values.

The curve for chlorine follows that of the protein and the ash, but a study of the figures for chlorine does not show any striking relationship between the viscosity of the secretion and the chlorine value. Both high and low values occur in all three classes of the secretion. Where, however, several samples of the secretion from the same woman were taken at different stages during the antenatal period, it was noticed that, if the ash value varied, the increase or decrease coincided with a corresponding variation in the chlorine value. In one case, for instance, where the value of the ash rose from 0.44 to 0.52 %, the chlorine value rose from 45 mg. to 48 mg. per 100 ml.

The average values for the very viscid (21) class 3, the less viscid (40) class 2, and the watery (14) class 1 secretions are respectively 0.106, 0.1158 and 0.1307 g. per 100 ml., the watery secretion showing the highest average. It has not been possible so far to estimate the alkali metals and magnesium, and it may be that the chlorine percentages are related to these elements.

SUMMARY.

1. A total of 78 specimens from 53 women of the antenatal secretion for periods from 2 months before parturition up to the time of labour and in labour were analysed. The constituents studied were protein, sugar, ash, calcium, phosphorus and chlorine.

2. The results have been compared with work on postnatal milk during the first 10 days after labour and also with similar work on cows.

3. In all cases results suggested from our previous work as to the probable composition of the antenatal secretion have been obtained, suggestions have been made to account for certain experimental facts, but there are points for which at present no explanation can be offered.

4. A comparison of the relative proportions of the main ingredients of the fluid secreted by the mammary gland before and after parturition shows that a true difference in secretory activity is involved and not merely a difference in concentration.

5. A study of the physical properties of the antenatal secretions shows them to fall into three classes: (1) a beige watery fluid, (2) an opalescent more viscid fluid and (3) a very viscid cream to bright yellow fluid. All three forms were found during the last 2 months of pregnancy and could not be correlated either with absence or presence of previous lactation or, as in the case of cows, with the period of pregnancy.

6. In all cases the protein value for the antenatal secretion is higher than for that obtained after labour, and these values tend to fall into two groups with a mean value of 7 %.

The protein values of the secretion for the first few days of lactation are higher in the primiparae than in the multiparae. There appears to be a definite relationship between the viscosity of the secretion and the percentage of contained protein.

7. In the case of the sugar low values are obtained before labour, the mean value lying between 2.5 and 3.9 %.

In sugar content, as with protein, the samples tend to fall into two groups, 2 % rising to 6 % and 3.8 % rising to 8 %.

A definite relation exists between the viscosity of the secretion and the sugar percentage.

8. The percentage of ash in the antenatal secretion is always high, and in the five cases examined in labour the percentage was over 6 %. As in the case of protein irregular figures are shown before labour, falling steadily and persistently after labour to a more or less constant level.

9. In the case of calcium, while the fact that very considerable differences exist between the averages for individual women obscures the interpretation of the figures, yet from the average values the conclusion may be drawn that the percentage of calcium oxide is lowest during labour, rarely rising above 0.03 before labour, and steadily rising to a maximum after labour.

10. The phosphorus percentages in the antenatal period are very low, the highest percentage (P_2O_5) being only just over 0.028. The curves for phosphorus follow very closely those for calcium.

The calcium/phosphorus ratio before parturition is higher than that obtained after parturition. This is consistent with the work of Bar on the needs of the developing foetus for this element.

11. The percentage of chlorine is consistently very strikingly higher in the antenatal than in the postnatal period. There appears to be no clear relationship between the viscosity of the fluid and the percentage of chlorine present.

The curves run parallel for chlorine, protein, and ash.

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