position of the obstetrician is in a very uncertain state of equilibrium, and that this condition of affairs calls for early readjustment. Whether the adoption of a law such as exists in America and France (and it has much to recommend it) should be made is a matter for serious consideration. But whatever may be done, the law should emphasise in some very decided way a patient's legal right of privilege which she can only waive, except—and the law should make the exceptions—in certain well-defined cases. It does so now in the notification of infectious diseases, it may in the future do so in the case of contagious diseases, and it ought to specify in other cases what the doctor must reveal.

As things now are, the public generally think that professional reticence is merely the fastidious rule of a fastidious profession, contrary, as they often signify, to common sense. But, and until there is a clearer understanding between the law and the medical profession, and something definite achieved in this direction, the obstetrician and medical practitioner should bear in mind that it is the duty of the law to detect crime, that the Public Prosecutor is alone responsible for its proper investigation, and that the duty of the physician is simply to his patient. For his own protection, about which the law thinks nothing, the general practitioner at least should never induce premature labour without consultation with another medical man, that in all cases of suspected criminal abortion he should safeguard himself by calling in as early as possible another independent medical witness, and that never under any circumstances whatever should he be induced to examine a woman without her full consent, and preferably in the presence of witnesses.

And now the last few moments which end my presidency are gone, and it only remains for me to reiterate my gratitude for your kindness, and for the great honour you have done me. In my successor you will find not only a much more worthy President, but a familiar friend; one already accustomed to the duties of this chair, and one whom we all delight to honour, not only for the work he has done for this Society, but for his high standing as a gynaecologist, obstetrician, and teacher.

REFERENCE.

1 BRITISH MEDICAL JOURNAL, 1896, i, p. 871.

SOME OBSERVATIONS ON THE COMPOSITION OF HUMAN MILK.

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A TRUSTWORTHY estimate of the average composition of healthy human milk is most desirable for two reasons. In the first place it affords a standard by which we may judge of the quality of a mother's milk in cases where such milk disagrees with her infant; and in the second place it provides us with a standard by which we may adjust the composition of an artificial food for an infant during the suckling period. The table on page 200 represents the results of analysis of 94 samples of human milk. They were derived almost entirely from women admitted into the lying-in department of the Birmingham Workhouse Infirmary. With 7 exceptions all the samples were taken at some time within the puerperal month. There is every reason to believe that by this time human milk attains a composition which does not vary to any important extent during the later period of normal lactation.

The methods of analysis adopted were as follows:

TOTAL SOLIDS (WATER) AND ASH.

Five grammes were weighed into a tared platinum basin and evaporated to dryness on the water bath; the drying was continued in a water oven till the weight was practically constant. The residue was weighed as total solid matter, and the loss considered as water. The residue was then carefully ignited over a small flame till a white ash was left; it was found that the organic matter burnt easily if the basin was not covered during the ignition and the ash was not fused.

FAT, PROTEIDS, AND SUGAR.

Five grammes were weighed into a beaker and diluted with 50 c.cm. of distilled water; 2 c.cm. of a solution of copper sulphate (65 g. per litre), and a tenth normal solution of caustic soda dropped in, till the precipitate settled rapidly in curdy flakes; after some hours' repose, the clear liquid was decanted into a Gooch crucible, and the precipitate was then washed, first by decantation and then on the crucible with distilled water by means of reduced pressure. The crucible and its contents were then dried in the water oven till the precipitate dried in flakes; the crucible was placed in a small beaker, filled with ether, and left to macerate for twenty-four hours, at the expiration of which time it was submitted to a thorough washing with ether, the beakers and stirring rods being also rinsed with ether. This treatment was again repeated after a further drying. The crucible was then dried in the water oven till constant in weight; it was next ignited, at first gently, and finally strongly, and the difference between the weight after drying and that after ignition was taken as the proteids. This is the well-known Ritthausen method slightly modified in detail.

The combined ethereal solutions were evaporated in a small flask, and the residue, after heating in the water oven till the weight was constant, was considered as fat. This was examined in Zeiss's butyro-refractometer at a temperature of 35° C. to obtain the refractive index. In several cases the fat was also estimated by the Adams, Werner-Schmidt, or Gerber methods, and no appreciable difference was observed.

The filtrate from the precipitate produced by copper sulphate was used in several cases for the determination of the sugar by weighing the copper oxide produced on boiling with Fehling's solution. Estimations were also made by polarising the filtrate obtained by adding acid mercuric nitrate, or an acetic acid solution of picric acid to the milk. In all the analyses reported, however, the results for sugar were taken by difference; the reason for this will be discussed later.

Our methods differ only in detail from those adopted by Leeds; they give excellent results with cow's milk, and here the sugar deduced by difference agrees well with that estimated by Fehling's solution or by polarisation. In one particular we are totally at variance with him, as he finds that his analyses add up to 100 per cent. when all the constituents are directly determined; we find that ours are seriously below that total, when we attempt to take our estimated figures for lactose to represent the sugar. We will refer again to this.

We have noticed the fact recorded by Leeds that the fats are often, though not always, tinted green: this we find to be due to the presence of copper, and appears to be caused by the presence of free fatty acids in the fat. We find that the copper is easily removed from the green fats by shaking with dilute hydrochloric acid, and the fat then contains free fatty acid; the fat obtained in other processes also contains free fatty acid, and a similar colour may be obtained when a neutral fat (as that of cow's milk) receives an addition of a fatty acid.

The following table shows the amount of copper found in some of the fats, together with our notes of the colour:—

Serial Number.	Percentage of CuO in Fat.	Remarks.
19	2.80	Very deep green.
7	1.27	Very green.
12	0.87	Green.
15	0.62	Green.
16	0.30	Slight green.

The colour is directly proportionate to the percentage of copper in the fat; all figures are corrected by subtracting the percentage of copper oxide.

From the table the following arithmetical mean may be calculated:

Specific gravity	... 1031.3	Sugar	... 6.59
Water	... 88.04	Proteids	... 8.97
Fat	... 3.07	Ash	... 0.26

Table Representing the Results of Analysis of 94 Samples of Human Milk.

Mother.				Child.		Milk.							Remarks.
Name.	Age.	Pregnancy.	Health.	Age.	Health.	Specific Gravity.	Water.	Fat.	Sugar.	Proteids.	Ash.	R.I.F.	
1. R. L.	19	1st	Robust	3 days	Not thriving	—	86.75	3.23	—	—	0.38	Deg. 52.8	Death on 5th day; milk upset the child from the first.
5. "	—	—	—	4 "	—	—	86.95	2.94	5.78	4.05	0.28	55.4	
2. K. N.	19	1st	Indifferent	5 "	Good	1035.0	87.65	2.37	7.69	2.04	0.27	55.4	Mother had acute rheumatism a few months ago; child thriving remarkably, especially during 3rd week.
6. "	—	—	—	6 "	—	1033.5	86.69	3.63	7.40	2.02	0.26	54.0	
14. "	—	—	—	15 "	—	1028.0	90.06	2.25	6.17	1.32	0.20	48.9	
19. "	—	—	—	30 "	Very good	1031.7	87.10	3.95	7.11	1.64	0.20	48.2	
4. S. A.	30	4th	Good	16 "	Good.	1035.2	87.79	2.59	7.80	1.58	0.24	51.0	
3. L. F.	19	1st	"	10 "	Bad	1027.6	87.48	4.13	4.80	3.11	0.48	54.2	Child died on 8th day; sample taken 2 days later.
7. F. S.	24	2nd	"	23 "	Good	1028.1	84.58	6.91	6.71	1.60	0.20	52.0	
8. E. T.	36	3rd	"	9 "	"	1032.4	88.60	2.60	6.93	1.63	0.24	—	
15. "	—	—	—	11 "	—	1033.4	88.49	2.51	7.30	1.46	0.24	51.1	
20. "	—	—	—	31 "	—	1033.1	89.72	1.50	7.03	1.52	0.23	50.0	
9. M. M.	33	3rd	"	9 months	Good	1032.3	91.40	0.47	6.90	1.02	0.21	—	Before suckling.
10. "	—	—	—	9 months	Good	1030.6	89.48	2.51	6.79	1.14	0.18	—	After suckling.
11. I. M.	20	2nd	"	6 "	Good.	1031.6	89.13	2.50	6.83	1.36	0.18	—	Before suckling.
12. "	—	—	—	6 "	—	1029.5	86.53	5.15	6.84	1.28	0.20	—	After suckling.
13. H.	28	1st	Syph. ?	9 days	Good.	1033.7	86.66	3.86	7.39	1.81	0.28	52.0	
16. A. B.	19	1st	"	5 "	—	1034.7	86.95	3.45	7.05	2.26	0.29	51.8	
21. "	—	—	—	19 days	—	1031.1	85.94	5.08	7.08	1.69	0.21	50.8	
31. "	—	—	—	37 "	—	1031.6	87.69	3.51	6.75	1.82	0.23	52.4	Before suckling.
32. "	—	—	—	37 "	—	1031.2	87.59	3.68	6.74	1.78	0.21	52.0	After suckling.
75. "	—	—	—	3 months	—	1031.4	88.25	3.39	6.61	1.52	0.23	53.8	Before suckling.
76. "	—	—	—	3 "	—	1030.2	86.95	4.41	6.88	1.54	0.22	54.0	After suckling.
17. E. M.	35	2nd	Good	9 weeks	Good	1032.2	89.66	1.88	6.90	1.33	0.23	50.3	Before suckling.
18. "	—	—	—	10 "	—	1030.2	88.78	3.06	6.67	1.25	0.24	51.9	
22. C. W.	19	1st	Good	13 days	Good	1032.6	85.63	4.68	7.33	2.11	0.25	51.5	
23. Incog.	20	"	"	24 "	—	1034.7	89.21	1.62	7.04	1.88	0.25	51.1	Before suckling.
24. "	28	"	"	5 weeks	Failing	1042.6	88.01	1.22	8.89	1.55	0.33	51.9	
25. L. S.	29	3rd	"	5 days	Good	1027.5	90.34	2.03	4.38	2.75	0.50	55.6	Before suckling.
26. "	—	—	—	—	—	1032.1	88.40	2.66	6.36	2.30	0.28	53.5	After suckling.
27. N. K.	21	1st	Good	4 days	Good	1032.1	86.72	3.92	6.61	2.47	0.28	54.4	Before suckling.
28. "	—	—	—	4 "	—	1032.4	87.00	3.74	6.73	2.26	0.27	54.0	After suckling.
30. J. P.	31	4th	Good	4 "	Good	1031.9	87.90	3.09	6.33	2.34	0.34	54.0	Before suckling.
33. R. J.	21	1st	Good	10 "	Good	1026.8	87.94	4.20	5.20	2.32	0.34	53.8	After suckling.
34. "	—	—	—	10 "	—	1027.2	88.43	3.47	5.08	2.66	0.36	51.1	Before suckling.
35. C. F.	22	2nd	Good	5 "	Good	1027.9	88.70	3.15	5.36	2.52	0.27	52.8	After suckling.
36. "	—	—	—	5 "	—	1027.3	89.23	2.53	6.03	1.96	0.25	53.1	Before suckling.
37. E. M.	28	1st	Good	9 days	Good	1031.8	88.91	2.25	6.37	2.20	0.27	53.3	After suckling.
38. "	—	—	—	9 "	—	1030.8	86.87	3.94	6.65	2.26	0.28	50.6	Before suckling.
39. E. S.	23	2nd	Unhealthy	8 "	Good	1034.2	87.70	2.78	6.06	2.28	0.28	51.4	After suckling.
40. "	—	—	—	8 days	—	1031.5	87.70	3.32	6.63	2.10	0.25	50.7	Before suckling.
41. P. S.	20	1st	Good	5 "	Good	1035.0	88.87	1.75	7.38	1.90	0.21	50.1	After suckling.
42. "	—	—	—	5 "	—	1033.3	87.40	3.12	6.68	2.40	0.31	50.1	Before suckling.
43. "	—	—	—	14 "	—	1033.5	87.36	3.12	6.70	2.51	0.31	50.1	After suckling.
44. "	—	—	—	14 "	—	1028.0	87.58	4.09	5.64	2.32	0.37	49.1	Before suckling.
45. N. G.	27	1st	Good	11 "	Good	1030.2	86.31	4.75	6.42	2.21	0.31	49.1	After suckling.
46. "	—	—	—	11 "	—	1028.5	87.22	4.35	5.75	2.33	0.35	48.9	Before suckling.
48. "	—	—	—	17 "	—	1027.6	88.41	3.48	5.04	2.73	0.34	49.4	After suckling.
49. "	—	—	—	17 "	—	1033.7	87.71	2.91	7.07	2.04	0.27	48.0	Before suckling.
47. R. R.	21	2nd	Very anæmic	14 "	Fair	1031.9	88.47	2.79	6.89	1.61	0.24	50.9	After suckling.
50. "	—	—	—	20 "	Good	1029.0	88.09	3.28	5.60	1.76	0.27	52.8	Before suckling.
51. "	—	—	—	20 "	—	1029.5	86.23	4.99	7.25	1.44	0.19	51.4	Before suckling.
52. E. P.	20	2nd	Good	7 "	Strophulus	1032.0	88.38	3.03	6.95	1.45	0.19	51.0	After suckling.
53. "	—	—	—	7 "	—	1031.6	87.72	3.33	6.63	2.06	0.26	53.3	Before suckling vomited frequently; restless.
54. "	—	—	—	10 "	Good	1031.2	87.71	3.37	6.72	1.95	0.25	53.2	After suckling.
55. "	—	—	—	16 "	—	1030.2	89.96	1.91	6.62	1.26	0.25	50.4	Before suckling vomiting ceased; doing well.
56. S. D.	21	2nd	Phthisis	9 "	Delicate	1032.1	89.10	2.49	6.81	1.38	0.22	52.5	After suckling.
57. "	—	—	—	9 "	—	1032.6	89.57	1.95	6.75	1.49	0.24	52.0	Before suckling.
59. "	—	—	—	15 "	Failing	1031.4	89.06	1.62	6.71	1.47	0.24	51.8	After suckling.
60. "	—	—	—	15 days	—	1033.0	88.82	2.39	7.03	1.50	0.26	51.8	Before suckling.
58. L. M.	2	2nd	Tuberculous disease of wrist	5 "	Bad	1029.0	89.40	2.66	6.03	1.64	0.27	51.9	After suckling.
61. L. K.	26	"	Good	11 "	Good	1030.0	87.11	3.96	5.40	3.19	0.34	55.8	After suckling, vomiting, diarrhoea.
62. "	—	—	—	11 "	—	1031.3	87.62	3.32	7.16	1.65	0.25	53.3	Before suckling, colostrum 4 days.
65. "	—	—	—	21 "	—	1032.3	88.10	3.04	7.11	1.50	0.25	52.6	After suckling.
66. "	—	—	—	21 "	—	1031.1	88.46	2.89	7.18	1.30	0.17	52.9	Before suckling.
63. K. W.	34	2nd	Good	6 "	Good	1029.1	88.74	2.67	7.15	1.26	0.18	52.8	After suckling.
64. "	—	—	—	6 "	—	1032.2	87.64	3.27	7.09	1.73	0.27	53.0	Before suckling.
67. K. C.	18	1st	Good	7 "	Upset	1036.3	89.23	1.23	7.50	1.77	0.27	52.5	After suckling.
68. "	—	—	—	—	—	1031.3	89.54	0.87	5.19	4.02	0.38	58.4	Before suckling (child always crying, and died in convulsions 8 days old).
69. E. S.	22	1st	Good	7 days	Bad	1032.4	89.39	1.87	5.74	2.65	0.35	56.6	After suckling.
70. "	—	—	—	7 "	—	1030.5	90.13	0.99	5.35	3.16	0.37	58.2 ?	Before suckling.
73. "	—	—	—	11 "	—	1031.0	88.45	2.10	6.55	2.54	0.36	58.0	After suckling.
74. "	—	—	—	11 "	—	1028.6	88.36	3.70	5.53	2.05	0.36	52.3	Before suckling.
71. F. S.	26	2nd	Good	10 "	Good	1026.7	87.57	4.71	4.87	2.47	0.38	52.6	After suckling.
72. "	—	—	—	10 "	—	1031.9	87.05	3.71	7.11	1.91	0.22	52.0	Before suckling.
77. E. T.	19	1st	Good	16 days	Good	1032.0	87.00	3.74	7.12	1.93	0.21	52.1	After suckling.
78. "	—	—	—	16 days	—	1030.6	87.12	3.80	7.20	1.65	0.23	53.4	Before suckling.
79. F. N.	24	2nd	Epileptic	7 "	Good	1030.8	87.25	3.72	7.18	1.63	0.22	53.3	After suckling.
80. "	—	—	—	7 "	—	1031.6	88.75	1.88	7.27	1.87	0.23	54.8	Before suckling.
						1033.4	89.00	1.64	7.29	1.84	0.23	55.0	After suckling. } Glycosuria.

Table Representing the Results of Analysis of 94 Samples of Human Milk—(continued).

Mother.				Child.		Milk.								Remarks.
Name.	Age.	Pregnancy.	Health.	Age.	Health.	Specific Gravity.	Water.	Fat.	Sugar.	Pro- teids.	Ash.	R.I.F.		
81. R. E.	20	1st	Good	5 "	Dyspeptic	1030.9	87.35	3.43	6.42	2.48	0.32	Deg. 55.8	Before suckling; griping; flatu- lence; diarrhoea.	
82. "	—	—	—	5 "	—	1033.9	88.29	2.16	6.70	2.52	0.33	—	After suckling.	
83. E. H.	19	1st	Good	15 "	Strophulus	1034.3	89.29	1.59	6.86	1.97	0.29	—	Before suckling.	
84. "	—	—	—	15 "	—	1034.5	89.31	1.62	6.81	1.98	0.28	—	After suckling.	
91. "	—	—	—	22 "	—	1027.1	84.72	6.65	6.64	1.77	0.23	—	Before suckling.	
92. "	—	—	—	22 "	—	1024.0	82.93	8.82	6.29	1.74	0.22	—	After suckling.	
85. E. B.	31	1st	Very anæmic	9 "	Delicate	1036.3	89.35	0.81	6.50	2.83	0.33	—	Before suckling; child always in pain and crying; diarrhoea; vomiting on 7th day.	
86. "	—	—	—	9 "	—	1034.5	88.95	1.48	6.45	2.79	0.33	—	After suckling.	
89. "	—	—	—	16 "	Better	1028.6	88.65	2.84	6.81	1.67	0.23	—	Before suckling; child rapidly improving.	
90. "	—	—	—	16 "	—	1026.3	86.08	5.71	6.30	1.69	0.22	—	After suckling.	
87. A. M.	27	1st	Good	12 "	Good	1034.0	89.41	1.62	6.81	1.90	0.36	—	Before suckling.	
88. "	—	—	—	12 "	—	1032.5	89.40	1.67	6.76	1.90	0.27	—	After suckling.	
93. M. M.	36	6th	Good	11 "	Small and weak	1031.2	90.59	0.98	6.52	1.71	0.20	—	Before suckling.	
94. "	—	—	—	11 "	—	1027.6	87.65	4.07	6.31	1.77	0.20	—	After suckling; child did badly. vomiting, diarrhoea on 14th day; very deficient supply.	
Mean	—	—	—	—	—	1031.3	88.04	3.07	6.59	1.97	0.26	—		

Perhaps a more exact method of obtaining the average composition is that of "percentile grades," devised by Galton. By this method the 50-percentile grade is:

Specific gravity	1031.6	Sugar	6.75
Water	88.10	Proteids	1.87
Fat	3.08	Ash	0.25

For the purpose of comparison we subjoin a few of the analyses of human milk most frequently referred to by writers on the subject:

	Vernois and Becquerel.	Clemm.	Payen.	Tidy.	Frey.	Lehmann.	Leeds.
Water	88.91	90.58	89.54	86.27	90.01	88.5	86.7
Proteids	3.92	2.91	3.35	2.97	1.05	1.7	1.9
Fat	2.67	3.34	3.34	5.37	4.34	3.8	4.1
Sugar*	4.36	3.15	3.77	5.13	7.61	6.0	6.9
Ash	0.13	0.19	—	0.22	0.21	0.2	0.2

* Vernois and Becquerel estimated sugar by the polariscope as lactose; this we find to be about 2 per cent. lower than taking it by difference; adding 2 per cent. to the sugar, and subtracting 2 per cent. from the proteids (which Vernois and Becquerel took by difference) it is seen that their results agree fairly well with ours.

It will be seen that some of these results differ widely from those obtained by us—notably that of Vernois and Becquerel—which has hitherto been more generally quoted by authors than any other. While making full allowance for actual differences in the composition of human milk, we cannot but think that some of the variations referred to are due to faulty methods of analysis. On the other hand, our results very closely correspond to those obtained by Lehmann and by Leeds.

It is a matter of some interest and importance to note the proportions of the different ingredients of milk to each other. Thus, the ratio of fat to carbohydrates is as 1 to 2.2 nearly; that of fat to proteids is as 1 to 0.6; while that of proteids to carbohydrates is as 1 to 3.6. These ratios correspond almost exactly to those observed in the results of investigations conducted at Munich as to the smallest amounts of food compatible with health, under 1½ year of age.¹ These conclusions were arrived at by actual trial of food stuffs in different proportions, evidence quite distinct from that deduced from the composition of milk.

VARIATIONS.

Our analyses show that pretty wide variations in every ingredient of milk are met with. The widest variations are met in the fatty constituents, the largest amount being 8.82

per cent., while the lowest is only 0.47 per cent.; proteids vary from 4.05 per cent. to 1.02 per cent.; while the proportion of sugar varies the least, namely, from 8.89 per cent. to 4.38 per cent. From the fact that the arithmetical mean of each ingredient differs so slightly from the 50-percentile grade—as previously shown—it may be concluded that the variations from the normal are disposed with approximate equality above and below it.

SPECIFIC GRAVITY.

The specific gravity of any given sample of milk represents the resultant as between the amount of fat and solid constituents other than fat which are present. The former tends to reduce and the latter to increase the specific gravity. This fact, together with the varying amounts of each of the solid constituents other than fat, render untrustworthy all conclusions calculated from the specific gravity as to the percentage proportion of any individual solid constituent. The highest specific gravity we obtained was 1042.6 (No. 24); this is probably due to the low percentage of fat (1.22) and the high percentage of sugar (8.89) and ash (0.33). The percentage of proteids in this sample is rather below the average (1.55). The lowest specific gravity we obtained was 1024 (No. 92), due to the very high percentage of fat (8.82). More than a third (32) of the samples examined yielded a specific gravity between 1031 and 1032.5.

WATER.

The highest percentage of water recorded is 91.4 (No. 9). This was a very poor milk of 9½ months' lactation, containing the smallest percentage of fat in the whole list, and poor also in proteids. It was taken, however, before suckling. The sample from the same woman after suckling was much better. The percentage of water fell to 89.48, that of fat rose to 2.55, and of proteids to 1.14. The lowest percentage of water recorded is 82.9, occurring in Sample 92, associated with the lowest specific gravity (1024), and the highest percentage of fat in the whole list.

FATS.

The highest percentage of fat recorded is 8.82 (No. 92), while the lowest is 0.47 (No. 9). More frequently than not the proportion of fat is larger in the samples taken after suckling than before.² The average composition of the milk before and after suckling was

	Before Suckling.	After Suckling.
Water	88.33	88.04
Fat	2.80	3.18
Sugar	6.51	6.53
Proteids	1.99	1.09
Ash	0.28	0.26

It is seen that the only important difference is in the percentage of fat. In 8 cases the analyses were sensibly identical—that is, difference in fat less than $\frac{1}{4}$ per cent., and in the other constituents less than $\frac{1}{10}$ per cent.

This is more obviously the case with milk taken after lactation has become fully established. During the colostrum period, and for a variable time afterwards, the rule that fat is higher after suckling is often reversed. The difference between the milks before and after suckling may be largely mechanical, and due to the separation of cream in the breast. If the secretion is constant in composition, the first portion drawn will be above or below the normal in fat according to the position of the mother; if she is in a prone position the cream will be drawn off first, and this may account for the fact that we very frequently observed that the milk before suckling was high in fat in the earlier stages of lactation.

It is worthy of remark that in one case (Nos. 41 and 42) the analyses were almost absolutely identical, and here the secretion was excessive; it may be reasonably supposed that the cream had no time to rise. The reverse is the case where secretion was very deficient (Nos. 93 to 94), where the largest difference in fat is observed.

The difference in the refractive index suggests that the fat of milk differs from that of cow's milk.

SUGAR.

The proportion of this ingredient of maternal milk is subject to much less fluctuation than that of fat or proteids. The highest percentage observed was 8.89 (No. 24), the same sample which exhibited the highest specific gravity, namely, 1042.6. The lowest percentage observed was 4.38 (No. 25), representing as nearly as possible a half of the maximum percentage. The results obtained by estimation of the sugar by means of the polariscope, as lactose were found to be entirely different from the quantity of sugar ascertained by analysis, thus suggesting a special difference in composition. A sample of the sugar was prepared according to the method used by one of us in conjunction with Pappel³ to separate the sugar from the milk of the gamoose. The milk was mixed with acid mercuric nitrate (2 per cent.), and the clear filtrate neutralised (to phenolphthalein) with dilute caustic soda (not potash). After filtering from the precipitate, the mercury in solution was removed by sulphuretted hydrogen, and the solution evaporated and left to crystallise; the first crop of crystals was seen under the microscope to consist of rhomboid plates (not the usual wedge-shaped crystals of lactose, which were absent), mixed with amorphous matter. A little of this dissolved in water was fractionally precipitated by the gradual addition of alcohol, a flocculent precipitate was first produced, and on further addition of alcohol a crystalline precipitate was obtained. The specific rotatory power $[\alpha]_D$ of the first mother liquor (corrected for mineral matter) was about 26.8°. After several recrystallisations a sugar was prepared nearly free from mineral matter, which crystallised wholly in rhomboid plates, and gave no flocculent precipitate with alcohol. This had a specific rotatory power of 48.7 degrees, while the specific rotatory power of lactose (anhydrous) is 55.3 degrees.

By oxidation with nitric acid a large quantity of mucic acid was formed, larger than that given by the same amount of lactose. Treatment with phenylhydrazine acetate produced an osazone soluble in hot water and crystallising on cooling and resembling phenyllactosazone in appearance; a product somewhat like the anhydride of phenyllactosazone was observed, but in very minute quantity.

It is also worth noting that human milk does not taste sweet, while a 7 per cent. solution of lactose, artificial human milk made from cow's milk with 7 per cent. of lactose and asses milk (with about 7 per cent. lactose) all have a distinctly sweet taste.

Determinations of sugar were made in several milks by polarisation and by Fehling's solution gravimetrically and compared with the results deduced by difference: in every case a serious deficiency was noted.

From the following table we feel justified in concluding that the sugar of human milk is not lactose; there is some evidence that two sugars are present, a crystalline aldobiase, and an amorphous substance (animal gum?).

Sugar by Difference.	Sugar Polarised. (α) _D 48.7°	Sugar by Fehling calculated as Lactose.
5.78	4.66	5.22
6.93	—	6.35
8.89	—	7.94
7.69	6.02	—
4.80	2.58	—
7.80	6.63	—
7.40	6.27	—
6.71	5.44	—
6.81	5.83	—
6.30	5.45	—

By the method used for preparing the sugar, there is no difficulty in preparing lactose in a state of purity from the milk of the cow, gamoose, and ass.

The quantity of sugar obtained was very small, and did not admit of further research, but we hope to prepare further quantities for study.

PROTEIDS.

The variation between the maximum and minimum percentages occupies a place midway between that of sugar and fat. The highest percentage observed was 4.05 (No. 5), while the lowest was 1.02 (No. 9). As a general rule, the percentage of proteids diminished after the first week of lactation. From the extreme importance of being able if possible, to estimate the approximate percentage by some ready and easy method we endeavoured to devise a simple formula for this.

If we assume that the degrees of gravity added to the percentage of fat give the degrees of gravity of the milk from which all the fat has been removed (a rule which holds with remarkable accuracy with cow's milk), and further assume that the sugar and ash are constant, and deduce the gravity of a solution containing 6.75 per cent. sugar and 0.25 per cent. ash in 97 parts of water, as 29.6, we take the difference of $G + F - 29.6$ to be equal to the gravity due to proteids; this figure divided by 2.8 will give the percentage of proteids.

The formula is: Proteids = $\frac{G + F - 29.6}{2.8}$ and is deduced from the known specific gravity of the sugar proteids and ash of cow's milk. Applied to our average figures ($G = 32.6$, $F = 3.08$), the proteids work out at 1.82, which is in close agreement with the average found, 1.87. This formula is nothing more than a quantitative expression of Holt's method of ascertaining the amount of proteids, and may be applied to show the validity or otherwise of Holt's method.

Applied to our analyses in many cases the results are good, but the exceptions are so numerous and so marked (negative results even occurring) that we are obliged to abandon it. Especially is the failure marked when we attempt to apply the method to the milks which did not agree. Other formulae have been calculated by purely mathematical methods from our results without any greater success. We can only conclude that Holt's method is based on a fallacy.

It is hardly necessary to point out that the proteids of human milk differ from those of cow's milk by not yielding a curd with rennet, and by giving a much finer precipitate with acetic acid. We have observed that a solution of cow's milk neutral to phenolphthalein gives a precipitate at once with copper sulphate, and if this ignited a green residue (copper phosphate?) is left. Human milk under these conditions yields no precipitate, but requires a further addition of alkali, and the precipitate then obtained yields a black residue on ignition (due to copper oxide).

ASH.

The percentage of ash varies from a maximum of 0.5 to a minimum of 0.17, but in the large majority of samples it varied between 0.23 and 0.28. As a general rule, when the percentage of ash was high that of proteids was also high, but this is by no means always so. Thus in Sample 3, $A = 0.48$, $P = 3.11$; in No. 25, $A = 0.50$, $P = 2.75$; in No. 30, $A = 0.34$, $P = 2.32$; while in No. 65, $A = 0.17$, $P = 1.30$; in No. 10, $A = 0.18$, $P = 1.14$.

REFRACTIVE INDEX OF FAT.

This was determined as the only practicable indication of variation in composition of fat; it is, however, affected by

two distinct chemical facts. Broadly speaking, the lower the molecular weight the lower is the refractive index; also the larger the percentage of unsaturated glycerides (for example, olein, linolein) the higher the refractive index. A low percentage of volatile fatty acids (such as butyric) which have a low molecular weight would cause a high refractive index; a high percentage of olein would also cause a high refractive index.

The highest refractive index we have noticed is 58.4° , while the lowest is 48.2° ; as a comparison we may give the figures for some other fats, determined by one of us:

Butter fat, average 46.1, maximum 48.4, minimum 44.6
Palm-nut oil " 41.6 (low molecular weight)
Cotton-seed oil " 51.6 (high olein and linolein).

This determination affords a ready means of demonstrating that the fat of human milk has by no means the same composition as that of cow's milk.

CLINICAL REMARKS.

There were 5 deaths among the 42 children suckled on the various samples of milk submitted to analysis. It is a remarkable fact that in each of the fatal cases, with one exception, the percentage of proteids was high, ranging from 2.05 to 4.02. In one fatal case the percentage was 1.71 before and 1.77 after suckling; but here the labour was very prolonged, the child was in a miserable condition at birth, and the supply of milk was very scanty. In every case but 3 of the whole number in which the proteids exceeded 2.5 per cent, the milk disagreed. Variations in the percentage of the other ingredients seem to be much more readily borne. It is a matter of regret that the details of nutrition were not closely followed in those children which appeared to be doing fairly well at the time the samples of milk were taken.

In the following table we give the analyses of the milk in all cases in which the health of the child was not good:

C.	Case.	Water.	Fat.	Sugar.	Proteids.	Ash.	R.I.F.	Remarks.
1	A	86.75	3.23	—	—	0.38	52.8	Infant died.
5	A	86.95	2.94	5.78	4.05	0.28	55.4	Infant died.
3	B	87.48	4.13	4.80	3.11	0.48	54.2	Failing.
24	C	88.01	1.22	8.89	1.55	0.33	51.0	Fair.
47	D	88.09	3.28	5.60	1.70	0.27	52.8	Strophulus, vomiting.
52	E	87.72	3.33	6.63	2.06	0.26	53.3	Vomiting, diarrhoea.
53	E	87.71	3.37	6.72	1.95	0.25	53.3	Failing.
58	F	87.11	3.96	5.40	3.19	0.34	55.8	Failing.
59	G	88.82	2.39	7.03	1.50	0.26	51.8	Failing.
60	G	89.40	2.66	6.03	1.64	0.27	51.9	Failing.
67	H	89.54	0.87	5.19	4.02	0.38	58.4	Died.
68	H	89.39	1.87	5.74	2.65	0.35	56.6	Died.
69	I	90.13	0.99	5.35	3.16	0.37	58.2	Died.
70	I	88.45	2.10	6.55	2.54	0.36	58.0	Died.
73	I	88.36	3.70	5.53	2.05	0.36	52.3	Died.
74	I	87.57	4.71	4.87	2.47	0.38	52.6	Griping, flatulence, diarrhoea.
81	J	87.35	3.43	6.42	2.48	0.32	55.8	Griping, flatulence, diarrhoea.
82	J	88.29	2.16	6.70	2.52	0.33	—	Griping, flatulence, diarrhoea.
83	K	89.29	1.59	6.86	1.97	0.29	—	Strophulus.
84	K	89.31	1.62	6.81	1.98	0.28	—	Strophulus.
91	K	84.72	6.65	6.64	1.77	0.22	—	Strophulus.
92	K	82.93	8.82	6.29	1.74	0.22	—	Pain, diarrhoea, vomiting.
85	L	89.53	0.81	6.50	2.83	0.33	—	Supply deficient, child died.
86	L	88.95	1.48	6.45	2.79	0.33	—	Supply deficient, child died.
93	M	90.59	0.98	6.52	1.71	0.20	—	Supply deficient, child died.
94	M	87.65	4.07	6.31	1.77	0.20	—	Supply deficient, child died.

In cases A, B, F, H, I, J, and L, an excessive amount of proteids was found, accompanied in H, I, and L with a serious deficiency in the fat. In Case c (for which we are indebted to the kindness of Dr. Marston Low), the very abnormal amount of sugar and the deficiency of fat are the probable causes of disagreement. In case M the milk is not abnormal, but the supply was deficient. Cases D, E, and G, show no marked difference from the mean, but in these cases the infant was not seriously ill. Case K is peculiar; the first samples were deficient in fat, while the later ones contained the largest amount recorded; possibly the irregular secretion may be the cause of disagreement.

If we eliminate these analyses, we find as the composition of milk which agrees with the infants as follows:

Water.	Fat.	Sugar.	Proteids.	Ash.	Refractive Index of Fat.
[88.12]	3.11	6.70	1.83	0.24	51.9°

while the average of milk which disagreed with the infants was:

Water.	Fat.	Sugar.	Proteids.	Ash.	Refractive Index of Fat.
88.11	2.95	6.28	2.36	0.31	54.3°

The milk which agreed with the infants may be further subdivided according to the time that has elapsed since parturition:

Time Since Parturition.	Water.	Fat.	Sugar.	Proteids.	Ash.	Refractive Index of Fat.
4 to 6 days	88.01	2.97	6.47	2.25	0.30	53.2°
7 to 14 "	88.21	3.06	6.62	1.85	0.26	51.5°
15 to 29 "	87.74	3.42	6.95	1.67	0.22	51.4°
Over 30 "	88.53	3.00	6.83	1.43	0.21	51.7°

From the above table we feel justified in concluding:

1. That the proteids and ash decrease as lactation advances.
2. That the sugar has a tendency to increase.

There is a certain amount of evidence, also, that the composition of the fat (indicated by the refractive index) differs in the earlier stages of lactation from that present later. In this particular an analogy to the fat of cow's milk is well marked; it is known that butter fat is considerably poorer in volatile acids (butyric, etc.) in the early stages of lactation than the normal fat, and its refractive index is higher.

The milks which disagreed with the infants show in most cases the characteristics of milk in the early stages of lactation (high proteids, ash, and refractive index, and low sugar) to an exaggerated degree, suggesting that in these cases the normal functions of the breast are delayed, and that the colostrum period is prolonged. This is especially the case if only those cases are taken where either the child died (except M, in which the supply was deficient) or where vomiting and diarrhoea were observed.

REFERENCES

- ¹ Quoted by Landois and Stirling, *Human Physiology*, vol. i, p. 481.
² Reiset (*Ann. Chem. Phys.*, 1849-89) in 4 cases found the fat considerably higher after suckling than before; in 1 case the fat was nearly identical. Bouchardat and Quevenne (*Du Lait* ii, 77) and Forster (*Berichte*, 1881, 591) give analyses of three successive portions of milk; in every case (6 in all) the fat was lowest in the first portion, higher in the middle portion, and highest in the last. ³ *Jour. Chem. Soc.*, lvii, 754. ⁴ Cf. Tolmatscheff (*Zeitsch. f. Chem.*, 1868, 254), Clemm (*Wagner's Handwörterbuch f. Physiol.*, ii, 450), Griffith (*Chem. Gaz.*, 1848, 192), and Leeds (*Chem. News*, 1884, 1, 301).

SOME OF THE WAYS IN WHICH MILK BECOMES PATHOGENIC.*

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THIS communication contains the results of an examination of over 110 samples of milk sent to me by Professor Hope, of Liverpool, and Dr. Niven, of Manchester, for the purpose of determining the prevalence of tuberculous infection. While doing this work I was able to find evidence of the existence of contaminations which I considered went far towards explaining the occurrence of summer diarrhoea in artificially-fed infants and to a lesser extent in adults.

That diarrhoea is frequently caused by the consumption of milk is a view accepted by many authorities. What I have found is that milk very often becomes capable of producing considerable irritation through changes which take place after it has left the udder and has been under certain conditions. Part of the samples examined were obtained from diseased cows, the milk being carefully drawn into sterilised vessels and

* For a full account of this subject see *Journal of Comparative Pathology*, M'Fadyean, vol. x 1897, pp. 150 to 189.