

## THE LEUCOCYTOSIS OF LABOR AND THE PUERPERIUM.

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The first investigators to find a leucocytosis in pregnancy were Moleschott and Nasse (1). This observation has been confirmed by Mallassez (2), Halla (3), Fouassier (4), Virchow (5), Krüger (6), Kosina and Eckert (7), Limbeck (8), Rieder (9), and others. It has been found that most primiparæ have a leucocytosis in the later months of pregnancy, the average count being about 13,000. About 5 per cent of multiparæ have a leucocytosis, usually less high than the primiparæ. Virchow suggests as an explanation of the leucocytosis of pregnancy the gradual increase in size of the lymph vessels and glands about the uterus which occurs at this time, which then send a fresh supply of corpuscles into the blood. Rieder says there is no digestion leucocytosis in pregnancy.

A smaller number of observations have been made to determine the leucocytosis during and after labor. Kosina and Eckert found in 16 cases during labor 10,540 to 18,600 leucocytes per cub. mm. The count sometimes increased a little after delivery, but more often remained the same, and from the first day of convalescence gradually fell to normal. Krüger places the average in labor cases at about 13,000 leucocytes per cub. mm. Mallassez speaks of a rapid increase of leucocytes after delivery, followed by a gradual decrease to normal during convalescence. Rieder says the leucocytosis directly before and after birth is about two or three times the normal (7700) and falls rapidly from that time to the end of the puerperium. Cabot (10) counted 12 cases, 9 primiparæ and 3 multiparæ, during and after labor; the leucocytes varied from 10,000 to 37,000 in primiparæ, and from 11,000 to 16,000 in multiparæ. There was a rapid fall in count after confinement. Concerning the kind of white corpuscles causing the leucocytosis in pregnancy, Björkman (11) says, "In the last stages

of pregnancy we find an increase of the white mononuclear elements very manifest and constant in primiparæ." Rieder gives differential counts of two cases, one multipara and one primipara, with a leucocytosis of about 13,000, and says this is not due to an increased number of polynuclear cells. The different kinds of cells in these cases preserved practically their normal relations.

In puerperal sepsis Limbeck found no leucocytosis present. Kosina and Eckert say that in puerperal fever the count rises in proportion to its severity, and after the fever is over again falls. Rieder, Grawitz (12), Kanthack (13), and others, find a leucocytosis present. Cabot says a leucocytosis is absent in severe and mild cases, and present in those of moderate severity.

Limbeck affirms that the effect of lactation on leucocytosis is not known. He suggests that the increased consumption of food in lactation may increase it.

In the past year Dr. W. L. Richardson, visiting physician to the Boston Lying-in Hospital, kindly gave us the opportunity of making the following observations during his service. The blood of 55 hospital patients was examined with reference to the number and kind of white corpuscles present. Our object was to determine the amount of leucocytosis present in labor and in normal convalescence after confinement, the peculiarities due to the age of the patient, and the beginning of lactation; also the effect of hæmorrhage, prolonged labor, septicæmia and inflammation of the breasts in causing departures from the normal. It was hoped that in doubtful cases of septicæmia and suppuration of the breasts the blood count might be a help to early diagnosis.

The blood was examined in the 24 hours preceding delivery, usually in the first stage of labor; also on the 1st, 3rd, 5th, 7th, 10th and 13th days after confinement (see Table I). Thirty-three of the patients were primiparæ, 22 multiparæ, the ages varying from 16 to 41 years. Taking 10,000 leucocytes per cub. mm. as the maximum normal, a leucocytosis was found to be present before delivery in 84 per cent of the primiparæ and 75 per cent of the multiparæ, the average for 32 primiparæ being 15,021, an increase of 50 per cent above the normal,

TABLE I.

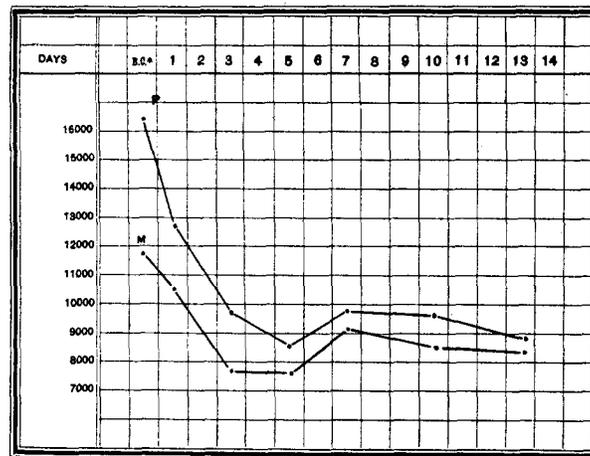
Case No.	Pregnancy.	Age.	Stage of labor.	Time of count before delivery.	Duration of labor in hours.	Hæmorrhage <sup>1</sup> .	Temperature.	Count before delivery.	Days of convalescence.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	REMARKS.
1	I	21	1st	5.20	11	Sl.	T.	9,600	14,880	15,000	11,200	10,100	12,800	14,800	9,400	9,000		7,600	13,200		2,900	Macerated foetus. 15th, 10,900; 16th, 19,300; 17th, 10,000. Inflammation of breast on 5th and 16th days.
2	I	21	2nd	2.00	(?)	N.	T.	14,500	13,600	15,000	11,200	10,100	12,800	15,500	9,400	8,800		10,600			8,000	Inflammation of breast on 8th to 10th day.
3	I	18	2nd	0.15	6	N.	T.	14,400	11,700	19,060	7,000	9,400	9,400	14,200	9,800	9,000		12,500			15,000	Sepsis.
4	I	24	1st	1.30	14	N.	T.	15,000	8,600	19,060	19,300	12,800	12,800	14,200	7,200	8,000		8,000			7,600	
5	I	23	1st	7.20	12	C.	T.	16,800	17,200	11,730	13,400	13,400	13,200	10,000	10,000	13,300		10,400			10,000	
6	I	23	1st	6.30	37	N.	T.	7,600	17,200	13,400	8,000	7,200	7,200	6,800	6,100	7,400		7,000			6,100	
7	I	22	1st	2.30	8	Sl.	T.	14,200	9,800	11,400	11,600	8,200	8,200	7,200	7,400	8,800		7,000			7,400	
8	I	22	1st	18.20	37	N.	T.	11,400	10,500	6,300	6,300	7,000	7,000	7,500	12,200	8,800		8,600			8,600	
9	I	23	2nd	0.30	6	Sl.	T.	21,200	7,800	6,400	6,400	7,500	7,500	7,500	7,500	7,500		7,000			9,000	17th, 7,200.
10	I	23	1st	7.00	20	Sl.	T.	10,200	6,400	6,500	8,200	12,000	10,100	10,100	10,100	10,100		14,200			18,100	
11	I	22	1st	7.20	108	Sl.	T.	15,600	8,800	6,900	8,200	7,500	7,500	13,000	12,200	12,200		7,000			9,000	
12	I	20	1st	7.20	20	N.	T.	15,600	8,800	6,900	8,200	7,500	7,500	13,000	12,200	12,200		7,000			9,000	
13	I	16	2nd	1.10	22	N.	T.	21,000	13,500	8,100	8,100	12,000	12,000	10,100	10,100	10,100		14,200			13,200	
14	I	21	2nd	2.25	43	C.	T.	30,600	19,400	10,400	10,400	10,100	10,100	10,100	10,100	10,100		14,200			13,200	
15	I	26	1st	5.00	53	N.	T.	14,100	18,600	9,600	9,600	13,600	13,600	13,600	10,800	10,800		10,100			7,600	Inflammation of breast on 4th to 7th day.
16	I	25	1st	4.00	17	N.	T.	24,300	24,900	11,700	11,700	11,700	13,600	13,600	10,800	10,800		10,100			7,600	
17	I	17	2nd	0.15	25	N.	T.	16,800	20,000	7,800	11,600	8,000	8,000	9,600	11,200	11,200		9,000			9,000	
18	I	18	1st	9.00	18	N.	T.	8,100	9,800	13,600	13,600	8,000	8,000	9,600	11,200	11,200		9,000			9,000	
19	I	17	1st	4.50	33	N.	T.	18,400	15,600	9,400	9,400	8,800	8,800	9,200	9,200	9,200		8,800			8,800	
20	I	22	2nd	2.00	12	N.	T.	12,600	10,600	11,900	11,900	8,000	8,000	8,000	8,000	8,000		12,000			11,700	
21	I	25	2nd	0.10	8	Sl.	T.	21,900	15,300	7,800	9,100	8,000	8,000	9,000	9,000	9,000		10,600			11,000	Temp. 101° on the 13th day, cause not known. 14th, 9,400.
22	I	21	1st	7.00	19	C.	T.	14,500	13,600	17,800	13,600	17,000	17,000	17,000	8,800	8,800		10,600			5,000	
23	I	21	1st	7.00	20	N.	T.	19,400	8,400	17,000	13,600	17,000	17,000	17,000	8,800	8,800		10,600			9,400	
24	I	21	1st	12.00	11	N.	T.	9,800	7,800	10,300	10,300	10,300	10,300	12,000	12,000	12,000		6,100			5,000	
25	I	17	1st	7.00	24	Sl.	T.	12,200	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000		9,200			9,400	
26	I	23	1st	27.00	41	N.	T.	12,200	12,300	14,000	14,000	11,600	11,600	9,600	9,600	9,600		10,600			11,500	
27	I	17	1st	1.40	45	N.	T.	15,500	12,000	9,100	9,100	7,600	7,600	8,200	8,200	8,200		10,300			8,400	
28	I	30	1st	4.00	12	N.	T.	8,000	9,400	5,900	5,900	8,400	8,400	10,000	10,000	10,000		11,200			6,900	
29	I	32	2nd	4.00	12	N.	T.	17,700	21,300	14,000	14,000	8,400	8,400	8,400	8,400	8,400		11,200			6,200	
30	I	27	1st	7.00	10	N.	T.	11,900	20,200	11,800	11,800	19,000	19,000	17,200	17,200	17,200		7,800			6,000	Inflammation of breast on 13th to 15th day. Eclampsia.
31	I	18	1st	0.25	7	Sl.	T.	8,400	9,900	8,600	8,600	9,100	9,100	9,400	9,400	9,400		7,400			5,000	
32	I	20	2nd	1.00	8	C.	T.	12,000	8,200	11,000	11,000	15,200	15,200	19,300	19,300	19,300		10,800			13,200	
33	I	17	1st	5.15	80	Sl.	T.	8,000	9,300	6,000	6,000	9,400	9,400	7,700	7,700	7,700		9,800			13,200	
34	II	22	1st	5.15	7	C.	T.	10,100	10,600	7,200	7,200	6,100	6,100	6,000	6,000	6,000		4,800			8,000	
35	II	22	1st	1.45	9	Sl.	T.	9,900	12,300	12,000	12,000	11,200	11,200	11,100	11,100	11,100		4,800			8,000	
36	II	19	1st	0.50	6	P.P.	T.	20,500	10,000	10,000	10,000	6,600	6,600	7,000	7,000	7,000		6,400			8,000	
37	II	24	1st	3.00	4	N.	T.	14,200	6,000	12,800	12,800	10,400	10,400	12,300	12,300	12,300		7,600			13,200	
38	II	26	1st	3.00	8	N.	T.	12,500	12,100	12,700	12,700	9,600	9,600	11,800	11,800	11,800		7,600			13,200	
39	II	30	1st	2.00	12	Sl.	T.	15,700	12,300	12,000	12,000	9,400	9,400	8,600	8,600	8,600		8,200			8,800	
40	II	27	1st	1.00	7	N.	T.	13,200	7,200	6,800	6,800	6,800	6,800	10,500	10,500	10,500		6,600			8,800	
41	II	26	2nd	0.55	9	N.	T.	13,300	12,400	8,400	8,400	8,400	8,400	10,400	10,400	10,400		8,000			8,000	
42	II	23	1st	1.00	8	Sl.	T.	11,100	12,300	7,600	7,600	10,000	10,000	10,000	10,000	10,000		6,300			9,400	
43	III	30	1st	1.20	33	C.	T.	8,000	8,800	8,800	8,800	5,500	5,500	8,200	8,200	8,200		6,400			6,200	
44	III	30	2nd	1.20	10	C.	T.	12,800	16,100	8,800	8,800	7,000	7,000	8,200	8,200	8,200		6,400			6,200	Alveolar inflammation on 10th day.
45	III	25	1st	3.00	11	N.	T.	10,200	11,200	10,100	10,100	5,900	5,900	10,600	10,600	10,600		5,500			6,800	
46	III	26	1st	1.80	11	C.	T.	17,200	10,800	8,000	8,000	5,900	5,900	16,800	16,800	16,800		5,500			6,800	
47	III	30	1st	1.80	4	N.	T.	10,600	10,300	6,900	6,900	5,800	5,800	4,100	4,100	4,100		8,300			5,500	
48	III	30	1st	5.00	10	N.	T.	10,500	6,000	6,000	6,000	5,900	5,900	6,200	6,200	6,200		8,300			6,800	
49	III	30	1st	5.00	6	N.	T.	8,600	8,300	7,000	7,000	6,000	6,000	9,400	9,400	9,400		6,600			5,500	
50	IV	39	1st	5.00	8	C.	T.	19,200	18,200	18,000	18,000	7,200	7,200	7,200	7,200	7,200		6,600			9,800	
51	IV	22	1st	5.00	6	N.	T.	8,600	8,300	7,000	7,000	6,000	6,000	9,400	9,400	9,400		6,600			9,800	
52	VII	34	1st	5.00	8	N.	T.	19,200	18,200	18,000	18,000	7,200	7,200	7,200	7,200	7,200		6,600			9,800	
53	IX	33	1st	5.00	6	C.	T.	19,200	18,200	18,000	18,000	7,200	7,200	7,200	7,200	7,200		6,600			9,800	
54	IX	35	1st	5.00	8	N.	T.	19,200	18,200	18,000	18,000	7,200	7,200	7,200	7,200	7,200		6,600			9,800	
55	IX	41	1st	5.00	11	N.	T.	19,200	18,200	18,000	18,000	7,200	7,200	7,200	7,200	7,200		6,600			9,800	

<sup>1</sup> Hemorrhage in delivery Sl. = slight, N. = normal, C. = considerable, P. P. = post-partum hemorrhage.

<sup>2</sup> Cases marked T. had a temperature over 100° during convalescence.

the average for 20 multiparæ being 11,700, an increase of 17 per cent. In 22 primiparæ and 17 multiparæ, the convalescence was perfectly normal and afebrile, and the average of the blood counts in these cases is taken to represent the normal leucocytosis of convalescence. The average for these primiparæ before delivery was 16,100, and for the multiparæ 11,800. The amount of the leucocytosis fell rapidly after delivery, reaching normal about the 4th or 5th day, then rose slightly till the 7th day, after which it gradually fell again to normal. This is graphically represented on the following chart (see Chart A). The curves for primiparæ and multiparæ show the same characteristics

CHART A.



\* B. C. = Before Confinement.

throughout, the number of leucocytes in the multiparæ being less. The disturbances in the breasts which commonly accompany the beginning of lactation, namely, swelling, induration and tenderness, are at their maximum from the 3rd to the 6th day after delivery, and it is interesting to note that the increase in the leucocytosis immediately follows this disturbance. We are inclined to regard this change in the blood as a result of the changes in the breast accompanying lactation. In considering the effect of age, the primiparæ were divided into two groups, those 21 years and under, and those over 21 years of age; and it was found that the leucocytosis in the younger women was

above the average. The same was true of multiparæ divided into two equal groups, above and below 26 years of age.

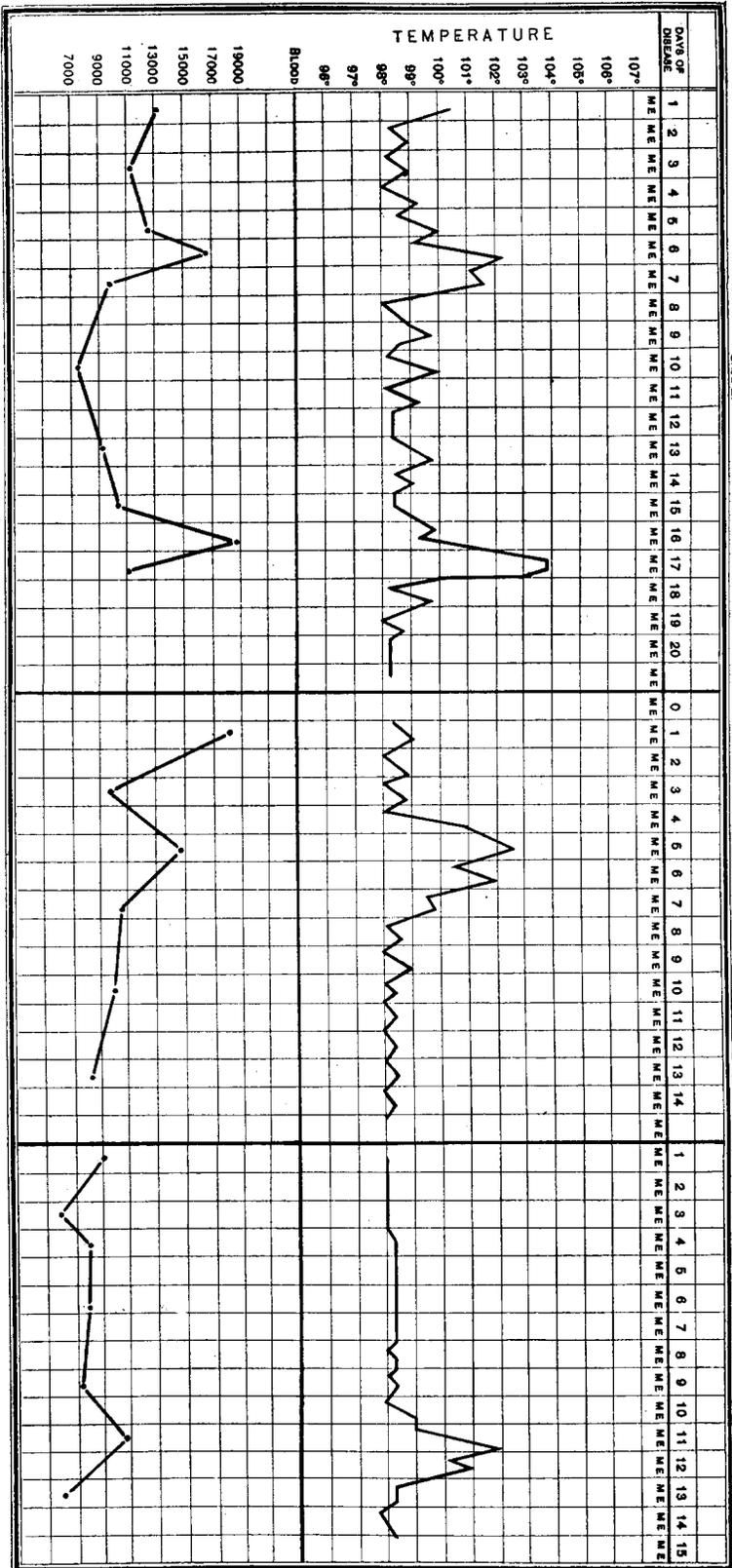
The variation in the leucocytosis early and late in labor was next considered. The counts were made at different times before delivery, and on dividing the counts in primiparæ into two equal parts, according as they were made within four hours of delivery or earlier, it was found that the early counts averaged 12,200 and the late ones 17,600. The multiparæ showed a similar but less marked contrast between the early and the late counts, 9300 and 12,00 respectively.

*Effect of Haemorrhage.*—The average blood counts of 5 multiparæ who lost considerably more than the usual amount of blood after delivery showed a leucocytosis about 1500 above the normal average the day after confinement. Two cases of severe post-partum hæmorrhage (Nos. 33 and 39; see table), one a primipara, the other a multipara, showed a leucocytosis of 3000 or 4000 above the normal average for the first five days after delivery, the worst case having 1,500,000 red corpuscles and 23,000 white corpuscles the day after confinement.

*Inflammation of the Breast.*—Four primiparæ (Nos. 2, 4, 15 and 30) during convalescence had an inflammation of the breast, accompanied with fever of about  $102^{\circ}$ , congestion and tenderness, and in two cases with a small definite red indurated area in the breast. The febrile attacks were all mild, lasting only two or three days, terminating in complete recovery and without any indication of the presence of pus. In all these cases there was a marked increase of the leucocytosis just at the time of the febrile attack, which disappeared, however, immediately after it, the maximum counts being from 11,000 to 19,000. This is graphically shown on the accompanying chart (Chart B). Case 2 had two separate attacks of mastitis on the 6th and 7th days, and on the 16th and 17th days of convalescence. Case 15 had mastitis from the 4th to the 7th day. Case 30 from the 12th to the 14th day. Further observation of these cases is desirable, but it would seem that inasmuch as the blood count is so strongly affected by mild cases of mastitis, it can be of little help in early diagnosis of the severe purulent form.

Only three cases of *septicaemia*, all of moderate severity, came under

CHART B.



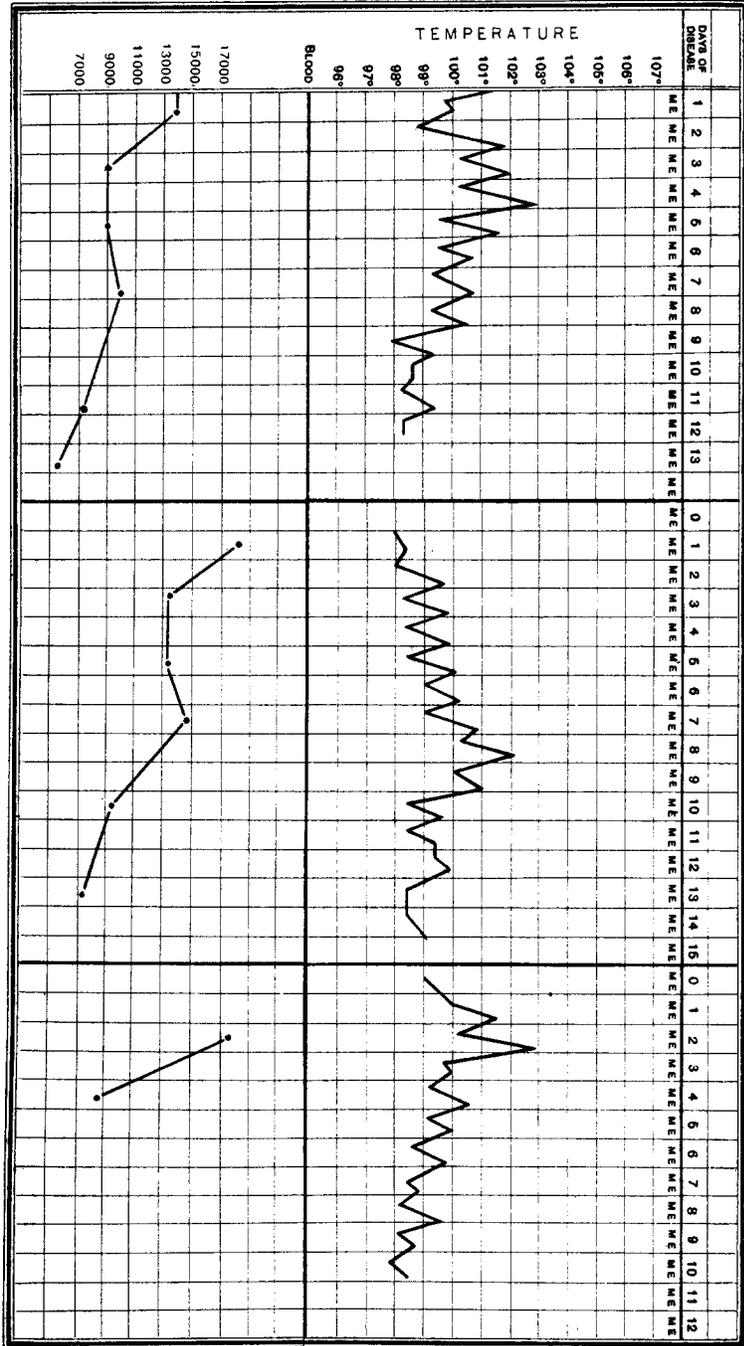


CHART C.

our observation. In Case 22 the leucocytosis ran a normal course; in Cases 6 and 55 there was a marked increase, the count varying from 14,000 to 17,000. When these patients had had the usual curetting and antiseptic treatment, and the fever and constitutional symptoms began to abate, the leucocytes subsided rapidly (see Chart C). Case 22 was curetted on the 3rd and 4th days; Case 6 on the 8th day; Case 55 on the 2nd day.

The septic cases are too few to serve as a basis for any conclusions.

It is interesting to note that in one fatal case of eclampsia (No. 31) the leucocytosis was 17,700 before delivery and 21,300 the following day.

TABLE II.

Case No.	Preg.	Leuco-cytosis.	Polynu-clears.	Large Mono-nuclears.	Lympho-cytes.	Eosino-philis.	Large Mono-nuclears. Absol. No. in 1 cmm.	Lympho-cytes. Absolute No. in 1 cmm.
14	I	30600	93.2	1.8	4.4	0.6	552	1346
16	I	24300	90.	3.	6.	1.	729	1458
21	I	21900	95.8	1.2	3.	.0	263	657
9	I	21200	90.4	1.6	8.	0.8	339	1696
13	I	21000	95.2	2.6	2.	0.2	546	420
40	II	20500	91.	4.	4.	1.0	820	854
24	I	19400	94.2	4.4	4.4	.0	272	820
19	I	18400	86.2	2.6	10.	1.2	498	1840
5	I	17200	92.	3.	4.	1.	516	688
50	IV	17200	79.6	.2.	16.8	2.6	344	2890
17	I	16800	89.	4.2	6.2	0.6	706	1042
4	I	15000	73.	5.	21.	1.	750	3150
2	I	14500	93.	1.6	5.4	0.	232	573
11	I	13000	80.	4.	15.	1.	520	1950
48	III	12800	86.5	4.5	8.1	0.7	576	1037
53	IX	8600	74.6	6.6	17.4	1.4	567	1496
34	II	8100	76.	6.4	17.2	0.4	518	1393
30	I	8000	74.2	7.2	17.9	0.7	576	1432
47	III	8000	72.	8.	20.	0.	640	1600

A differential count of the white corpuscles was made in 19 cases in labor, 12 with rather high counts, 4 with normal counts for comparison, and 3 of intermediate grade (see Table II). In the four normal cases the proportion of the different white corpuscles was practically normal. In the other 15 cases, with one exception (Case 4), the leucocytosis consisted in a marked relative and absolute increase of the polynuclear cells, the percentage of these cells being greater, as a rule, the higher the leucocytosis. There is a relative and slight absolute

diminution in the number of lymphocytes, while the large mononuclear cells are relatively diminished and absolutely are normal.

Our results differ markedly from those of Rieder and Björkman. We will sum up our conclusions briefly as follows:

- (1). A leucocytosis was present in over three-fourths of our cases in labor, being more frequent and higher in primiparæ.
- (2). During convalescence the count falls rapidly at first, later more gradually, to normal. About the 7th day there is usually a slight rise.
- (3). The leucocytosis is usually higher in the younger women, regardless of the number of the pregnancy.
- (4). The patients farthest advanced in labor have the highest counts.
- (5). Breast inflammation, even when mild, causes a prompt leucocytosis, hence the blood count has no value in the early diagnosis of breast abscess.
- (6). The leucocytosis present at the time of labor is due to an increase of the polynuclear cells.

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