

AN INVESTIGATION INTO THE LEUCOCYTOSIS OF EPIDEMIC CEREBRO-SPINAL MENINGITIS.

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THE following observations on the leucocytosis of cerebro-spinal fever were made in the year 1906 during the first part of the recent epidemic. 55 verified cases were admitted into Belvidere Fever Hospital during that year, and in 36 of these observations into the leucocytosis were made. The blood was examined usually every third or fourth day between 10 and 11 A.M. throughout the whole course of the disease. Daily observations were sometimes made with a view of observing the relation of the leucocytosis to the pyrexia, while in chronic cases observations were often only made at weekly intervals. The red corpuscles were not counted, nor was the hæmoglobin estimated. The blood was usually taken without pressure from the lobe of the ear, but occasionally it was found more convenient to collect it from the finger. Films were prepared at the same time and fixed and differentiated by Leishman's modification of the Romanowsky stain.

In the course of the present investigation the leucocytosis was estimated 259 times, and in 171 of these the different forms of leucocytes were counted. The patients were of both sexes and at all stages of life. For the differentiation of the leucocytes 500 cells were counted on the average.

The cases have been classified in the following four groups, already described in a former clinical description,¹ of the disease:—(I.) the acute cases; (II.) the abortive cases; (III.) the mild cases; and (IV.) the chronic cases. The acute cases number 10; the abortive, two; the mild, three; and the chronic, 21. All those in the first and last classes, with the exception of three chronic cases, were fatal, while in Groups II. and III. all the patients recovered. Of the acute cases five were males and five were females, their ages ranging from one year to 24 years; the two abortive cases were males, their ages being nine years and 20 years respectively; of the mild cases, two patients were females and one was a male, their ages being 31, six, and five years respectively; while of the chronic cases, 11 patients were males and 10 were females of ages varying from four months to 16 years.

To save undue repetition in the text the results of some of the observations have been collected in the form of tables, but as these observations are so numerous only a few of the most typical ones are inserted in this paper. Ehrlich's nomenclature has been used as that most generally approved. The tables give the morning and evening temperatures of the cases observed and the total number of leucocytes recorded on each observation, along with the absolute numbers and percentages of each variety of white cell observed on each occasion. In those instances where the total leucocytosis alone is recorded, a differential count was not made.

The general results of the observations may be briefly outlined. If we take 7000 to 8000 leucocytes per cubic millimetre of peripheral blood as the standard, it will be observed that the number of the leucocytes was constantly in excess of this. In one of the mild cases, however, a single count of 2600 cells was obtained. This case, though the pyrexia lasted 50 days, is included among the mild cases, because there were never any of the severer symptoms present, nor was the patient's life ever considered in danger. In addition it should be noted that the leucocytosis was due, as a rule, to an increase, both absolute and relative, of the polymorphonuclear cells. In those cases where the patients were infants or young children a distinct lymphocytosis, both absolute and relative, was very occasionally observed. This was more marked in the chronic form of the disease. The leucocytosis in the cases recorded was generally considerable. It has in general risen and fallen with the temperature.

The particular results in each type of the disease now fall to be discussed. The acute cases will be described first.

GROUP I.—Acute Cases (Fatal).

In the acute cases examined the patients were admitted between the third and sixth days of illness, and as all of them died within about from 24 to 48 hours after admission, only one observation was made except in one instance. In all these cases the leucocytosis was very considerable. The maximum number of white cells varied between 18,000 and 66,800, the latter being the highest individual count in any of the groups. The leucocytosis was always due to an increase, both absolute and relative, of the polymorphonuclear cells.

Even in infancy the leucocytosis is polymorphonuclear. In the case of a child (Case 4) aged only 16 months the percentage of polymorphonuclear cells was 88·75 and of lymphocytes 10·25, which is evidence of a very great increase. In the case of another child of the same age (Case 3) the percentage of polymorphonuclear cells was 54·4 and of lymphocytes 40, which is almost an exact interchange of the normal proportions and still shows a considerable increase.

The large mononuclear cells retained their normal relative proportions in four of the cases, and in the other six their relative percentage was very much reduced. In one instance (Case 6), in which the differential count showed 94·3 per cent. of polymorphonuclear cells, no large mononuclear cells were observed in the film examined. This diminution was absolute as well as relative in two of the cases (Cases 2 and 6).

Eosinophile corpuscles were not observed in the films examined of any of this series of cases. This is what one would expect to find, as these cells are recognised to be rare in cases of septic disease which are fatal. Complete absence of these corpuscles is found in typhus and pneumonia and plague, &c., and is observed apparently only in cases which eventually terminate unfavourably. As the acute form of cerebro-spinal meningitis was always fatal, it is noteworthy that eosinophile corpuscles were found absent in all of this group, although they were found in varying amounts in all the other forms of this disease.

GROUP I.—Acute Cases.

CASE 1.—The patient, aged 15 years, who was admitted to hospital on the fifth day of illness, died on the seventh day of illness.

Observations made on the fifth day of illness.—Temperature: morning, 101° F.; evening, 101·8°. Leucocyte count: total number, 27,600—polymorphonuclear cells, 25,875; lymphocytes, 1175; large mononuclear cells, 552; eosinophile cells, *nil*. Differential count: polymorphonuclear cells, 93·75 per cent.; lymphocytes, 4·25 per cent.; large mononuclear cells, 2 per cent.

CASE 2.—The patient, aged five years, who was admitted to hospital on the sixth day of illness, died on the eighth day of illness.

Observations made on the eighth day of illness.—Temperature: morning, 103·2° F.; evening, 103·8°. Leucocyte count: total number, 20,200—polymorphonuclear cells, 17,675; lymphocytes, 2373; large mononuclear cells, 152; eosinophile cells, *nil*. Differential count: polymorphonuclear cells, 87·5 per cent.; lymphocytes, 11·75 per cent.; large mononuclear cells, 0·75 per cent.

CASE 3.—The patient, aged one year and four months, who was admitted to hospital on the fourth day of illness, died on the fifth day of illness.

Observations made on the fifth day of illness.—Temperature: morning, 101·8° F.; evening, 103·8°. Leucocyte count: total number, 20,000—polymorphonuclear cells, 10,880; lymphocytes, 8000; large mononuclear cells, 1120; eosinophile cells, *nil*. Differential count: polymorphonuclear cells, 54·4 per cent.; lymphocytes, 40 per cent.; large mononuclear cells, 5 per cent.

CASE 4.—The patient, aged one year and four months, who was admitted to hospital on the fifth day of illness, died on the seventh day of illness.

Observations made on the sixth day of illness.—Temperature: morning, 99° F.; evening, 102°. Leucocyte count: total number, 23,400—polymorphonuclear cells, 20,768; lymphocytes, 2398; large mononuclear cells, 234; eosinophile cells, *nil*. Differential count: polymorphonuclear cells, 88·75 per cent.; lymphocytes, 10·25 per cent.; large mononuclear cells, 1 per cent.

CASE 5.—The patient, aged six years, who was admitted to hospital on the third day of illness, died on the fourth day of illness.

Observations made respectively on the third and fourth days of illness.—Temperature: morning, 101·8° F. and 98·4°; evening, 99·6° and 98·4°. Leucocyte counts: total number, 55,000 and 66,800—polymorphonuclear cells, 45,513 and 55,277; lymphocytes, 8525 and 9352; large mononuclear cells, 962 and 2171; eosinophile cells, *nil*. Differential counts: polymorphonuclear cells, 82·75 per cent. each day; lymphocytes, 15·5 and 14·0 per cent.; large mononuclear cells, 1·75 and 3·25 per cent.

CASE 6.—The patient, aged 13 years, who was admitted to hospital on the third day of illness, died on the fifth day of illness.

Observations made on the fourth day of illness.—Temperature: morning, 101·2° F.; evening, 101°. Leucocyte count: total number, 35,000—polymorphonuclear cells, 33,005; lymphocytes, 1995; large mononuclear cells, *nil*; eosinophile cells, *nil*. Differential count: polymorphonuclear cells, 94·3 per cent.; lymphocytes, 5·7 per cent.

GROUP II.—Abortive Cases (Recoveries).

This group comprised two cases, in both of which the leucocyte counts were taken after the temperature had

¹ THE LANCET, March 14th, 1908, p. 768.

become normal. In the one case (Case 11) the patient was admitted on the eleventh day of illness, and there had been no pyrexia from the time of admission onwards. In the other case (Case 12) the patient was admitted on the fourth day of illness, and the leucocytosis was obtained from the sixteenth to the twenty-seventh days of illness, although there had been an absence of pyrexia from the seventh day onwards unless for a temporary rise of temperature on the fifteenth day. Both patients, however, were still complaining of pains in the head and the back for several days after the disappearance of the pyrexia. In the former case (Case 11, patient aged 20 years) the estimate varied between 10,000 and 14,000. The relative percentage of the polymorphonuclear cells remained practically the same as in normal blood, but the relative percentage of lymphocytes was slightly increased at the expense of the large mononuclear cells, which were both absolutely and relatively diminished. In the latter case (Case 12, patient aged nine years) the estimate was from 14,000 to 23,400. Out of the four differential estimates made, the polymorphonuclear cells preserved the relative percentages obtained in adult normal blood on the first and last occasions. In the other two observations, a relative and absolute lymphocytosis was present, which might be accounted for in part by the youth of the patient. The large mononuclear cells were relatively diminished. This change was absolute as well as relative in one instance, and on one occasion these cells were entirely absent. Eosinophile cells were present throughout in the former case (Case 11), but were not observed in the latter case (Case 12) till far on in convalescence.

GROUP II.—Abortive Cases (Recoveries).

CASE 11.—The patient, aged 20 years, was admitted to hospital on the eleventh day of illness.

Day of illness.	Temperature.		Total number of—					Percentages of—			
	Morning.	Evening.	Leucocytes.	Polymorpho-nuclear cells.	Lymphocytes.	Large mono-nuclear cells.	Eosinophile cells.	Polymorpho-nuclear cells.	Lymphocytes.	Large mono-nuclear cells.	Eosinophile cells.
	°	°						%	%	%	%
12	98	99	12,200	8510	3446	61	183	69.75	28.25	0.5	1.5
13	98	99	13,000	8715	4355	65	65	65.5	33.5	0.5	0.5
17	98	98.4	14,000	9800	3990	175	35	70.0	28.5	1.25	0.25
19	98	99	10,000	6050	3875	25	50	60.5	38.75	0.25	0.5

GROUP III.—Mild Cases (Recoveries).

This group comprised three cases, in which all the patients recovered. The temperature remitted from 101° to 103° F. to about normal in the morning throughout the whole course of the fever, which lasted about from 40 to 50 days. The differential estimate was done in the first two cases (Cases 13 and 14) throughout the whole period of pyrexia. In the third case (Case 15) only one leucocyte count was taken and no differential estimate was made, so that no value can be attached to this observation unless to show that a single count taken at random revealed a leucocytosis. The number of white cells during the pyrexia varied in the first case (Case 13) between 10,000 and 30,000; in the second case (Case 14) between 2600 and 16,200. The single count in the third case (Case 15) revealed 24,000 white cells. With the fall of the temperature the leucocyte counts became normal. The leucocytosis in this group of cases was not specially high. As in the chronic group, it increased and decreased in a very irregular manner from day to day, and this can only be explained by the variability in the temperature. To a certain extent the leucocytosis has risen and fallen with the temperature in these cases, but this was not a constant phenomenon, nor did the variation in the number of the leucocytes show any correspondence with any other clinical symptom. In the second case (Case 14) the leucocyte count remained low from the fourteenth day onwards to the fiftieth day, when the patient was quite well. This change occurred the day after the patient had a first injection of anti-meningococcic serum, so that there was practically an absence of leucocytosis from that date onwards while the patient was under observation. A hypo-leucocytosis is recorded after the injection of antitoxic serum in

diphtheria, and as these low counts were quite exceptional in the ordinary course of the disease it may be presumed that they were due to the injection of anti-meningococcic serum.

In the first case (Case 13), that of a child, aged six years, the polymorphonuclear cells showed a relatively higher percentage than they normally should at that period of life. In a single differential estimate taken two days after the temperature had become normal, a relative and absolute increase of lymphocytes was obtained, and if we take this as approximating the normal percentage of the different forms of cells in this case then it might be reasonable to infer that the previous estimates revealed a polymorphonuclear leucocytosis. The large mononuclear cells were diminished both absolutely and relatively.

In the second case (Case 14), the relative percentage of the polymorphonuclear cells remained practically in the ratio observed in normal blood, unless on two occasions when the percentage was over 80. The relative percentage of lymphocytes was slightly increased at the expense of the large mononuclear cells, which were relatively and absolutely diminished, and on four occasions entirely absent.

Eosinophilic cells were present throughout in both cases. In the second case (Case 14) the proportion of these cells was as high as 5 per cent., but there was no real eosinophilia. This is interesting in view of the fact that in the acute cases, all of which were fatal, these cells were completely absent.

GROUP III.—Mild Cases (Recoveries).

CASE 14.—The patient, aged 31 years, was admitted to hospital on the fifth day of illness.

Day of illness.	Temperature.		Total number of—					Percentages of—			
	Morning.	Evening.	Leucocytes.	Polymorpho-nuclear cells.	Lymphocytes.	Large mono-nuclear cells.	Eosinophile cells.	Polymorpho-nuclear cells.	Lymphocytes.	Large mono-nuclear cells.	Eosinophile cells.
	°	°						%	%	%	%
5	—	102.4	11,600	9048	2494	29	29	78.0	21.5	0.25	0.25
8	98.2	102.6	13,400	9782	3350	201	67	73.0	25.0	1.5	0.5
9	100.2	101.2	12,000	—	—	—	—	—	—	—	—
10	101.8	103.8	16,200	—	—	—	—	—	—	—	—
11	98.4	104.0	14,000	—	—	—	—	—	—	—	—
14	100.4	103.8	12,200	9974	1983	152	91	81.75	16.25	1.25	0.75
17	98.0	103.8	9,000	6075	2700	—	225	67.5	30.0	—	2.5
19	99.4	102.4	7,000	4550	2310	—	140	65.0	33.0	—	2.0
20	98.4	102.4	7,200	5148	1872	—	180	71.5	26.0	—	2.5
21	98.4	99.8	7,600	5092	2052	76	380	67.0	27.0	1.0	5.0
23	99.6	100.8	4,600	3220	1150	—	230	70.0	25.0	—	5.0
25	99.6	102.4	6,000	4170	1606	30	195	69.5	26.75	0.5	3.25
29	102.2	99.8	11,600	—	—	—	—	—	—	—	—
33	100.2	101.2	2,600	—	—	—	—	—	—	—	—
37	99.2	100.4	7,600	—	—	—	—	—	—	—	—
39	97.0	102.0	9,400	6204	3032	23	141	66.0	32.25	0.25	1.5
44	97.4	99.6	10,400	8398	1794	208	—	80.75	17.25	0.2	—
50	98.8	98.8	6,800	4536	2142	102	—	67.0	31.5	1.5	—

GROUP IV.—Chronic Cases (21 Cases; Three Recoveries).

This group comprised 21 cases, in 16 of which a differential estimate was made throughout the course of the disease. The patients were all infants and children from four months to seven years of age, unless in the instance of a girl, aged 16 years. All but three had a fatal issue, but a differential estimate was made in only one of the former (Case 29). There was so much variability in the course of the temperature in these cases that classification was impossible. The number of white cells varied markedly from day to day without relation to the course of the disease and without reference to any particular law. There was not a gradual increase to a maximum and decline to a minimum, and it cannot be stated definitely at what period of the disease the leucocytosis was greatest, as this was so variable, occurring both at the commencement, the middle, and the end of the disease. The number of white cells varied in this group between 7000 and 59,000. The leucocytosis was

due essentially to an increase, both absolute and relative, of the polymorphonuclear cells. As the majority of the cases were in infants and young children the relative percentage of these cells was naturally not increased to such an extent as one would expect to find in the adult, but it was sufficiently high to indicate in practically all instances a distinct polymorphonuclear leucocytosis. In a child aged six months (Case 30) the relative percentage of the polymorphonuclear cells was only once as high as 42, and towards the end of the disease it fell to 21. This, however, is quite physiological in a child of this age, and the case is quoted in order to show the influence that age has on the leucocytosis, as it is well known in the various pathological leucocytoses that, while otherwise one may have constantly a polymorphonuclear increase, in the case of young infants occasionally a relative and absolute lymphocytosis may be observed. In another child of younger age (Case 21), on the other hand, there were on an average 60 per cent. of the polymorphonuclear cells, which is a considerable increase for a child of that age. In three children, all aged 18 months (Cases 17, 18, and 23) the average relative percentage of the polymorphonuclear cells was 74, 80, and 83 respectively. This reveals also quite a marked increase of these cells at this period of life. In still one more instance, a patient, aged five years (Case 29), the behaviour of the leucocytosis is worthy of special description. In this case there was a form of fever with periods of apyrexia lasting from three to seven days, followed by febrile periods, remittent in character, having about a similar duration. The pyrexia lasted 160 days and the patient eventually recovered, and this was the only instance, out of the three recoveries in this group, in which a differential count was taken throughout the course of the disease. From the 121st to the 125th days, and from the 128th to the 138th days, the leucocytosis was observed every day in order to see if it varied with the rise and fall in the temperature. It was observed that the blood count was, as a rule, particularly high during the periods of pyrexia, but was of only moderate extent during the afebrile periods. On the 125th day a count of only 10,400 was obtained, but this can be explained by the fact that the period of pyrexia in that instance did not commence till the evening of that day, when the temperature reached 102·6° F. On the 128th day a count of 26,200 was obtained, although the morning and evening temperatures remained normal, but this may also be explained by the fact that the temperature had just fallen on that day and the period of apyrexia was just commencing. It cannot be definitely stated that the leucocytosis corresponded with the temperature in this way throughout the whole course of the disease, and it may be noted in this connexion that, although the patient was usually well when the temperature remained normal, at other times this was not the case. The leucocytosis in this instance was essentially a polymorphonuclear one, and this was most evident, as a rule, during the periods of pyrexia. Quite frequently, however, both a relative and absolute lymphocytosis was obtained both in the periods of pyrexia and apyrexia, although oftener in the latter, but this may be accounted for by the fact that the patient was only five years of age. In the remaining ten cases of this group in which a differential estimate was made, the leucocytosis was quite definitely polymorphonuclear. In two instances in children (Cases 27 and 28) there was a tendency towards a slight lymphocytosis towards the end of the disease.

The large mononuclear cells had an average relative percentage of 5 throughout the whole of this group. This percentage was sometimes slightly decreased and in other instances a little increased in individual cases, but remained fairly constant throughout. In consideration of the fact that the majority of the cases were in young children the percentage of these cells was somewhat reduced, although it was higher and more constant than in any of the other three groups. The absolute numbers of these cells, however, were not definitely diminished. Eosinophile cells were present also in small amount in all of these cases during their whole course, although they were practically all fatal. In the only instance (Case 29) in which the patient recovered where the differential count was done these cells were not more constant or more numerous than in the other cases which proved fatal. Basophile cells were observed in four instances (Cases 27, 28, 30, and 31) at very occasional intervals. Their absolute numbers varied from 35 to 105, thus constituting a

slight basophilia. These cells, however, were not observed in the chronic case which recovered.

GROUP IV.—Chronic Cases.

CASES 16, 18, 21, and 30.—Case 16: Patient, aged five years, admitted to hospital on sixth day of illness; death. Case 18: Patient, aged 18 months, admitted to hospital on sixteenth day of illness; death. Case 21: Patient, aged four months, admitted to hospital on eighth day of illness; death. Case 30: Patient, aged six months, admitted to hospital on fifth day of illness; death.

Day of illness.	Temperature.		Total number of—					Percentages of—			
	Morning.	Evening.	Leucocytes.	Polymorpho-nuclear cells.	Lympho-cytes.	Large mono-nuclear cells.	Eosinophile cells.	Polymorpho-nuclear cells.	Lympho-cytes.	Large mono-nuclear cells.	Eosinophile cells.
Case 16.											
6	100·2	102·2	28,000	23,240	3080	1680	—	83·0	11·0	6·0	—
10	102·8	101·8	26,800	22,244	3216	1340	—	83·0	12·0	5·0	—
14	102·0	104·0	34,200	28,728	3420	2052	—	84·0	10·0	6·0	—
18	101·4	103·6	25,200	18,396	5296	1512	—	73·0	21·0	6·0	—
22	99·8	101·2	33,600	28,896	3360	1008	336	86·0	10·0	3·0	1·0
26	101·4	103·8	18,400	14,720	2944	414	322	80·0	16·0	2·25	1·75
31	99·4	103·2	16,800	13,944	2184	546	126	83·0	13·0	3·25	0·75
37	97·8	103·6	17,000	12,410	3570	1020	—	73·0	21·0	6·0	—
40	99·4	103·6	17,800	15,041	2180	534	45	84·5	12·25	3·0	0·25
42	97·0	101·2	19,000	17,150	1282	570	48	90·0	6·75	3·0	0·25
45	101·2	102·6	18,600	16,182	1813	558	47	87·0	9·75	3·0	0·25
47	97·8	101·6	20,000	16,000	3050	900	50	80·0	15·25	4·5	0·25
51	98·6	101·6	20,000	16,000	3200	750	50	80·0	16·0	3·75	0·25
54	100·6	102·2	18,800	15,604	2303	893	—	83·0	12·25	4·75	—
57	97·0	101·2	18,600	15,903	2092	605	—	85·5	11·25	3·25	—
61	97·0	98·0	17,400	12,832	3828	740	—	73·75	22·0	4·25	—
71	97·6	97·8	40,400	35,956	2826	1818	—	89·0	6·5	4·5	—
76	97·8	97·2	17,800	15,753	1246	801	—	88·5	7·0	4·5	—
Case 18.											
16	99·8	99·8	16,800	—	—	—	—	—	—	—	—
21	100·2	100·2	34,200	22,657	9833	1710	—	66·25	28·75	5·0	—
25	98·8	103·8	26,800	23,919	2077	804	—	89·25	7·75	3·0	—
29	100·8	102·4	23,000	20,182	1725	920	173	87·75	7·5	4·0	0·75
37	100·4	99·6	27,400	—	—	—	—	—	—	—	—
41	100·2	100·6	22,000	17,050	3960	990	—	77·5	18·0	4·5	—
44	102·8	103·8	16,600	13,778	2158	664	—	83·0	13·0	4·0	—
48	99·8	100·2	15,000	—	—	—	—	—	—	—	—
Case 21.											
9	103·8	103·8	59,200	36,260	20,276	2664	—	61·25	34·25	4·5	—
10	100·8	101·8	32,200	14,248	16,744	1208	—	44·25	52·0	3·75	—
11	101·2	101·8	21,000	14,542	5,618	840	—	69·25	26·75	4·0	—
13	99·8	99·8	29,200	18,396	9,490	1241	73	63·0	32·5	4·25	0·25
Case 30.											
8	102·4	101·8	17,800	7476	9746	578	—	42·0	54·75	3·25	—
25	97·0	99·2	16,000	—	—	—	—	—	—	—	—
29	98·0	98·0	14,000	—	—	—	—	—	—	—	—
31	97·8	97·0	16,200	—	—	—	—	—	—	—	—
36	97·0	99·0	15,400	5159	9394	578	269	33·5	61·0	3·75	1·75
40	97·4	97·2	15,200	4218	10,222	456	304	27·75	67·0	3·0	2·0
44	97·0	98·0	16,400	3485	12,136	533	164	21·25	74·0	3·25	1·0

In the last of these observations 82 (0·5 per cent.) basophile cells were observed.

Value as to Diagnosis and Prognosis.

From the point of view of diagnosis, epidemic cerebro-spinal meningitis as observed in the recent outbreak quite frequently resembles tuberculous meningitis, other forms of non-tuberculous meningitis, and pneumonia, and occasionally the clinical features are not unlike those of enteric fever, typhus fever, and bubonic plague. In attempting these diagnoses the presence of a leucocytosis is only of value in excluding typhoid fever coming on with meningeal symptoms, as it is well known a leucopenia is constantly present in the latter disease unless the illness is complicated by some inflammatory phenomena. While the diagnostic significance of

the condition of the blood in cerebro-spinal fever is found to have been of importance in differentiating between that disease and enteric fever, the same cannot be said regarding its significance in the other diseases mentioned.

In regard to tuberculous meningitis, it is very often quite impossible, from the character of its onset and clinical characteristics, to distinguish it from cerebro-spinal fever. In the former disease also, unlike other forms of tuberculosis, leucocytosis of the polymorphonuclear variety is now recognised to be almost invariably the rule (Da Costa), and thus the blood examination does not assist much in the diagnosis. An increase in the number of the white cells does not seem, however, to be so constant a feature of the blood in tuberculous meningitis as in the non-tuberculous forms, so that the absence of leucocytosis rather suggests the former, although the presence of leucocytosis does not of necessity exclude it.

In distinguishing between other forms of non-tuberculous meningitis, pneumonia, typhus, bubonic plague, and epidemic cerebro-spinal meningitis, the blood unfortunately offers but little help. There is a leucocytosis in all of these diseases of the polymorphonuclear variety. The eosinophile cells are absent in acute cases of cerebro-spinal fever ending in death, and are also absent in fatal cases of typhus. These corpuscles are also recognised to be very much reduced, if not entirely absent, in unfavourable cases of pneumonia and bubonic plague. In these respects, therefore, the blood of these diseases presents similar characteristics, and an examination of that fluid alone gives little or no help in arriving at a diagnosis. The only certain method of diagnosis is by lumbar puncture, by which procedure, and from a careful study of the character of the fluid obtained, and by bacteriological tests, an accurate diagnosis can be practically always arrived at.

As regards prognosis, little can be said concerning the general leucocytosis of epidemic cerebro-spinal fever. The fact that eosinophile corpuscles were not found in the acute fatal cases has already been mentioned and may be regarded as of grave significance. These cells, however, were sometimes absent during the acute stage of an illness which eventually became chronic. It may be inferred that if these cells are present during the acute stage, an unfavourable issue will not immediately ensue, but if no corpuscles of the eosinophile type are found during the acute illness it does not necessarily mean that a fatal termination will soon follow, as the case may eventually become chronic. The degree of leucocytosis in general appears to have little or no prognostic value.

General Conclusions.

An analysis of these observations under their respective headings and of the tables in which the various blood cells are dealt with leads to the following conclusions. 1. That cases of epidemic cerebro-spinal meningitis are always accompanied by a leucocytosis, whether the attack is acute, abortive, mild, or chronic. 2. That the character of the leucocytosis is practically the same in all instances, both adults and children, and is the result mainly of an increase in the number of the polymorphonuclear cells. 3. That, nevertheless, a lymphocytosis may be very occasionally observed in infants and young children. 4. That there is a relative decrease of the large mononuclear elements alike in fatal and non-fatal cases, though less marked in the chronic type. 5. That in the first three groups there is sometimes an absolute decrease of the large mononuclear elements and occasionally total absence of these cells. In the chronic group absolute decrease, like relative decrease, is little marked. 6. That eosinophile corpuscles in acute fatal cases are always absent, although present in varying degree in all the other groups.

While bearing these general conclusions in mind the full significance of the observations can only be determined after a careful and detailed analysis of the characters and numbers of the different groups of white cells as well as of the conditions under which these are present. In the present series the highest individual count was obtained in an acute case (Case 5, Group I.), the leucocytes numbering on one occasion 66,800. This degree of leucocytosis may be regarded as a rough gauge of the intensity of the infection, as it was usually greater in severe than in mild cases. In the two abortive cases (Cases 11 and 12, Group II.) the leucocytosis was observed after the temperature had become normal and convalescence was well advanced. The normal relative

percentage of the different cells was not much disturbed in these two cases, but it is necessary to bear in mind that their blood was not examined during the febrile period. In the two mild cases (Cases 13 and 14, Group III.) the leucocytosis, although polymorphonuclear, was only moderate. This may be taken to indicate that a moderately intense infection was linked to fairly well-developed resisting powers, as both these patients recovered.

It may again be noted that, although a hypo-leucocytosis was obtained from the fourteenth day onwards in one of these cases (Case 14), this may be accounted for by the injection of anti-meningococcic serum. The eosinophile cells were sometimes as high as 5 per cent. in the latter patient, who recovered, and this is interesting in view of the fact that in the acute fatal cases these corpuscles are absent. The number of white cells in general varies markedly from day to day and without relation to the course of the disease, nor can any clear relationship be established between the leucocytosis and the character of the temperature. As already stated, in one case (Case 29, Group IV.) the leucocytosis was observed to be very high during certain periods of pyrexia. This observation, however, was not invariable either as regards this patient or others. The large mononuclear cells were relatively diminished in all the cases, both in those ending fatally and in those which recovered, although not so markedly in the chronic group, so that no special significance can be attached to this fact. The occasional presence of basophile cells in four chronic cases (Cases 27, 28, 30, and 31) cannot be readily explained, unless due to the influence of some specific chemotactic substance.

It may be here remarked that myelocytes were never observed in any of the films examined. Blood platelets were always present in the blood of all the cases examined, sometimes in large numbers. No marked difference was noted in the frequency of occurrence of these elements in the fatal and non-fatal cases respectively.

As regards diagnosis, it may be again noted that the leucocytosis is only of value in excluding typhoid fever.

From the point of view of prognosis, the absence of eosinophile corpuscles in the acute stage of the disease may be considered of grave significance, but it does not necessarily mean that a fatal issue will immediately ensue as the case may eventually become chronic.

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A CASE OF INTESTINAL PSEUDO-PARASITISM DUE TO *CHILODON UNcinatus* [BLOCHMANN]

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HAVING examined the blood of a person apparently healthy who had just returned from Northern Rhodesia with a fellow traveller who suffered from severe intestinal bilharziasis, a marked eosinophilia of no less than 35 per cent. was detected. This finding led to the examination of the faeces, with the result that a few eggs of *Schistosoma mansoni*, characterised by their oval shape and large lateral spine, were discovered. At a second and third examination of the faeces on two occasions some days later no trematode eggs could be found, though carefully looked for. Slides prepared from shreds of faecal mucus presented, however, numerous specimens of *Chilodon uncinatus*.

The present paper will deal with the chilodon only. The schistosoma infection, its accompanying and foreshowing eosinophilia, the irregular voiding of the trematode's ova may be dealt with subsequently. A careful examination of the patient elicited nothing further than a slight amount of looseness of the bowels which had been his habit for several years. It may be stated that the patient, who had been a cavalry soldier, had served in India and had frequently visited South Africa. In making this statement we do not wish to convey the impression that the chilodon infection must have