BREINL ..

CHANGES IN THE NEUTROPHILE BLOOD PICTURE OF ARNETH OBSERVED IN CHILDREN LIVING IN TROPICAL QUEENSLAND

BY

A. BREINL

AND

H. PRIESTLEY

FROM THE AUSTRALIAN INSTITUTE OF TROPICAL MEDICINE, TOWNSVILLE

(*Received for publication* 28 *August*, 1914)

ONE CHART

One of the most important practical advances in haematology within recent years was the discovery by Arneth of the definite relationship in the number of neutrophile leucocytes containing a different number of nuclei or nuclear fragments.

In 1904 Arneth published a monograph pointing out, as the result of prolonged and painstaking researches, that during the course of certain infectious diseases the nuclear conditions of the neutrophile leucocytes vary in a definite direction.

Arneth divided the neutrophile leucocytes into five main classes, according to the number of nuclei or nuclear fragments they contained, and each class into a number of sub-classes.

His first class contained three sub-classes, according to the shape of the nucleus, being either sickle-shaped (W), baton-shaped (T), or resembling that of a typical myelocyte (M).

The other four classes, with two to five or more nuclear fragments, were sub-divided again in accordance with the shape of the fragments which are ribbon-shaped or round. The number of ribbon-like nuclei were tabulated under S (Schlinge), and the round nuclear fragments under K (Kern).

The following Table (I), quoted from his monograph, may serve as a typical example.

TABLE 1.—DR. A.

1			2			3				4						5 and more		
M	W	T	2K	2S	1K 1S	3K	3S	2K 1S	2S 1K	4K	4S	3K 1S	3S 1K	2K 2S	5K	4K 1S	3S 2K
—	—	4	—	17	4	2	13	14	19	4	—	7	4	8	2	1	1

Arneth counted one hundred successive neutrophile leucocytes, and tabulated the results. His observations indicate that the changes in the number of leucocytes of classes I and II were most important, and devised, as a convenient means for comparing the results in different cases, his index which is the sum of these classes. Bushnell and Treuholz (1908) found it advisable to add half the number in class III.

Arneth's original observations were made on blood films stained with Ehrlich's triacid stain. Later observers used Giemsa's stain with satisfactory results.

The average normal counts as given by Arneth (1904), Paulicek and Simon for adults, and by Esser (1906) and Orland (1907) for infants, are compiled in Table 2.

TABLE 2

	Class I	Class II	Class III	Class IV	Class V	
Arneth ...	5	35	41	17	2	Adults
Paulicek ...	4	28	52	14	2	,,
Simon	4 to 9	21 to 47	33 to 48	9 to 23	2 to 4	,,
Esser	5	25	35	29	6	Children
Orland ...	7	28	39	16	0	,,

The figures given by these observers agree on the whole fairly well, and can therefore be accepted as averages for normal individuals living in a temperate climate. According to the observations of Arneth, the numerical relationship of the neutrophile leucocytes becomes altered under the influence of certain infectious

diseases in the sense that the numbers belonging to the first two classes increase as compared with normal conditions. This change he termed a 'shift to the left.'

The question has since been extensively studied, and most of the observers obtained analogous results.

Chamberlain and Vedder (1911), during their investigations on the effect of a tropical climate on white men, performed seventy-two Arneth counts on American soldiers, and for comparison fifty on Filipinos. Their work led them to the conclusion that 'the average Arneth picture showed a marked shift to the left in the case of Filipinos and a slight drift in the same direction for Americans resident more than one year in the Philippines.'

The differential and Arneth counts on two groups of American soldiers—one consisting of twenty-eight pronounced blondes and the other of twenty-eight pronounced brunettes—did not reveal any material difference between the two types.

When comparing Chamberlain and Vedder's results, obtained on Americans in the Philippines, with the normal figures given by European observers (comp. Table 3), it becomes evident that the differences are sufficiently pronounced to justify their conclusion.

TABLE 3

	Arneth classification per cent.					Index Arneth
	I	II	III	IV	V	
Normal in Europe (Arneth)	5	35	41	17	2	40·0
Average for 72 healthy Americans in Philippine Islands	13·3	32·9	37·2	14·6	2	46·2
Average for 50 Filipinos	27·6	38·1	23·8	7·5	3	65·7

METHODS

The first few Arneth counts were performed by both of us on the same subjects, and were taken into consideration only after the results had become practically identical.

The blood films were stained by Giemsa's solution which, according to Pappenheim (1909), has certain advantages over Ehrlich's triacid. With the latter the nuclei stain indistinctly by the methyl green, and are more or less hidden by the darkly staining neutrophile granules; their contours are therefore difficult to distinguish. Giemsa's method has the additional advantage that the nuclei of leucocytes at the same stage of development are invariably stained to the same depth, and the connecting threads are sharply defined (Schilling-Torgau).

Two nuclear fragments, connected by a thread only, were counted separately, whilst they were counted as one when connected by a distinct bridge. In case of uncertainty regarding the class to which a cell belonged, the higher class was chosen. Only perfectly prepared films were used, and in each case 200 successive cells were enumerated. Each 100 was counted separately, and when the figures were consistent the count was accepted.

The blood films were made about the same hour of the day, in order to make the results as nearly comparable as possible. For comparison a few Arneth counts were made on recent arrivals from a temperate climate, and these differed but little from the averages given by Arneth.

RESULTS OF ARNETH COUNTS ON 150 CHILDREN

Arneth and differential counts were performed on the blood of 150 children (boys and girls) of ages between 7 and 15, and tabulated according to the ages (comp. Table 4). For completeness the average numbers of erythrocytes, leucocytes and the average haemoglobin value (Fleischl-Miescher) for the same children are appended, counts which have been included amongst the average figures referred to in our communication on the general blood condition of children of European descent residing in tropical Australia. The children were not selected in any way.

The individual counts were fairly consistent and did not vary to any great extent. After the completion of the first twenty-five counts the averages were computed, and have been found to agree almost completely with the total average of the 150 Arneth counts.

The averages given in the table indicate that the Arneth index of normal healthy children, who have resided in tropical Queensland for the whole or most of their life is very high indeed, when

compared with the corresponding figure of children living in a temperate climate; in other words, the Arneth blood picture of North Queensland children shows a well-marked 'shift to the left.'

An attempt was made to represent graphically our results and, for comparison, those of previous observers on normal Europeans (Arneth), on American soldiers in the Philippines, and for Filipinos (Chart 1). In this chart the classes are plotted out as abscissae and the percentages as ordinates; for the purpose of distinctness the points are connected by lines.

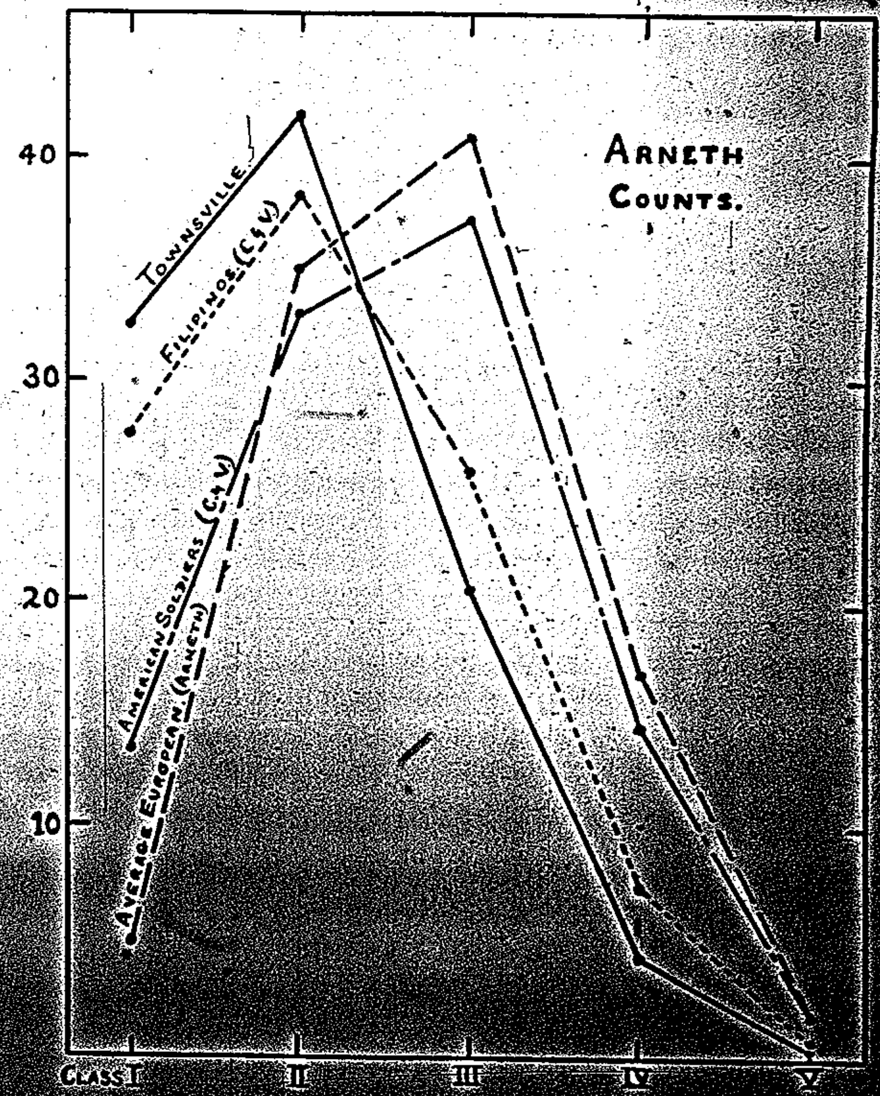

CHART I

The graph brings out clearly that residence in the tropics influences the Arneth blood picture in a manner analogous to certain infectious diseases.

The 'shift to the left' after a short residence is only slight (as shown by Chamberlain and Vedder's figures for American soldiers in the Philippines); it becomes more pronounced after a prolonged residence (as shown by the figures for Townsville children). In fact, the Arneth index of North Queensland children resembles closely that of Filipinos.

We have thus, in the altered Arneth picture, the only definite indication of the influence of a tropical climate *per se* upon the blood conditions of Europeans.

Most authors consider that a 'shift to the left' in the Arneth blood picture is the expression of a lowered resistance of the body to infection.

They base this conclusion upon the observation that numerous Arneth counts performed on patients suffering from phthisis showed a close relationship between the course of the disease and the number of neutrophile leucocytes in the lower classes. This, however, does not justify the assumption that the leucocytes of the lower classes are less actively phagocytic than those in the higher classes. If it were so, phagocytic experiments *in vitro* should reveal a distinct difference in the phagocytic power of neutrophile leucocytes of the different classes.

Busse (1910) carried out researches on this point and found that 'the leucocytes obtained from healthy human blood, from inflammatory and post-operative leucocytosis, show exactly the same phagocytic power.' Our tentative experiments in this direction confirmed his observation, and bear out the statement that the conception of Arneth, namely, that the leucocytes with a lesser number of nuclear particles play a less important rôle for the protection of the body, does not hold good for phagocytic experiments *in vitro*.

In our opinion, the Arneth picture is an expression of the functional activity of the leucopoetic system, especially the bone-marrow, rather than that of phagocytic activity. The presence of a large number of neutrophile leucocytes belonging to class one indicates a greater activity of the bone-marrow, but does not

necessarily imply that the resistance of the organism is lowered in any way.

Chamberlain and Vedder consider that in Filipinos this reduction in circulating phagocytic cells may be a visible indication of a lowered resistance to infection on the part of native races.

In our experience, there is amongst the children in North Queensland (Townsville) no greater susceptibility to infectious diseases than amongst the same class in Europe.

That natives are more prone to contract infectious diseases, imported by Europeans, is not the expression of a lowered resistance, generally speaking, but is the expression of the lack of acquired active immunity, enjoyed by the population in places where the diseases in question had been existent for centuries. In the same way Europeans emigrating to the tropics are more prone to contract diseases peculiar to the tropics and in a more severe form than the natives.

The similarity of the Arneth blood picture in North Queensland children with that of Filipinos does not, in our opinion, mean a lowered resistance to infection, but is in all probability the outcome of purely climatic influences.

DIFFERENTIAL LEUCOCYTE COUNTS

For the differential count 500 successive leucocytes were enumerated, and the results included in Table 4.

The figures obtained for the different classes resemble those obtained for normal persons in Europe. The average number of the polymorphonuclear neutrophile leucocytes shows slight changes, being somewhat lower than usually accepted. It must, however, be kept in mind that there are discrepancies in the results published by different authors. Whereas Ehrlich and Lazarus (1910) and Arpad v. Torday consider 65 to 70 per cent. as the normal average number of polymorphonuclear leucocytes, the averages of Hewes (1904) (55 to 65 per cent.) and of Bunting (1911) (54·6 per cent.) are somewhat lower.

When taking our individual differential counts into consideration, great variations are noticed in the children, the numbers of polymorphonuclear leucocytes ranging between 35 and 75 per cent., being in 20·6 per cent. of the children below 50 per cent. of the total number. On the whole there is therefore a distinct decrease in the number of this class of leucocytes.

TABLE 4.—Arneth and differential leucocyte counts on 150 children of North Queensland according to age.

Age	No.	Arneth classification per cent.					Arneth Index	Differential counts per cent.							Average Haemoglobin	
		I.	II.	III.	IV.	V.		Polymorphonuclear	Transitionals	Large Mononuclear	Lymphocytes	Eosinophiles	Mast Cells	Average Total No. of Leucocytes	Average Total No. of Erythrocytes	Absolute Value	per cent normal
7	6	35·5	43·3	17·6	3·5	0·3	78·8	55·9	5·6	1·4	30·8	6·2	0·1	10,816	4,971,200	12·09	87·5
8	12	35·2	41·6	18·8	4·1	0·3	76·8	52·2	6·3	2·7	28·9	9·9	0·00	9,794	5,169,300	11·63	84·5
9	18	30·6	41·3	23·2	4·4	0·5	71·9	58·6	4·5	2·5	28·0	6·3	0·02	12,244	4,696,500	12·15	88·0
10	20	32·7	42·0	20·0	5·0	0·3	74·7	56·1	4·3	2·2	30·1	7·3	0·0	10,173	4,987,400	12·21	89·0
11	17	30·1	45·3	19·6	4·6	0·4	75·4	55·5	3·3	1·8	31·7	7·6	0·05	9,627	4,955,300	12·12	88·0
12	30	33·8	41·7	20·1	4·0	0·4	75·5	57·4	4·7	3·2	26·3	8·5	0·05	10,370	5,132,400	12·55	91·0
13	33	31·0	41·3	22·5	4·7	0·5	72·3	54·2	3·2	2·2	32·3	8·0	0·03	10,544	5,072,700	12·61	91·5
14	11	34·9	42·4	18·9	3·3	0·5	77·3	59·6	3·2	2·5	27·0	7·6	0·03	10,351	5,256,700	12·95	94·0
15	3	33·3	41·0	19·3	5·7	0·7	74·3	56·8	5·1	1·1	31·9	4·9	0·1	10,555	5,421,900	12·53	91·0
Total Average	150	32·5	42·0	20·6	4·5	0·4	74·5	56·1	4·2	2·4	29·5	7·7	0·04	10,571	5,039,800	12·28	89%

This observation is in accordance with the finding of Chamberlain and Vedder, who obtained an average of 56·1 per cent. for the polymorphonuclear leucocytes of American soldiers in the Philippines in comparison with 56·8 per cent. for the Townsville children.

The average number of the eosinophile leucocytes is distinctly increased. Whereas 2 to 4 per cent. is considered normal in Europe, our average is 7·7 per cent., which is the more striking, since children suffering from helminthic infections had been as far as possible excluded.

The small number of brunettes amongst the children makes it impossible to draw any definite conclusions in respect to complexion and type.

CONCLUSIONS

1. The number of polymorphonuclear neutrophile leucocytes in the blood of children living in tropical Queensland is distinctly decreased, the number of the eosinophile leucocytes markedly increased.

2. The Arneth count performed on 150 school children living in tropical Queensland shows a marked shift to the left, the Arneth index being 74·5 as compared to 40 for normal individuals (Arneth) in Europe.

3. The 'shift to the left' in the Arneth blood picture is, in our opinion, due to the effect of a tropical climate upon the white race living in the tropics.

REFERENCES

ARNETH (1904). Die neutrophilen weissen Blutkörperchen. Jena.

ARPAD v. TORDAY (1913). Vom normalen Blutbild. Virchow's Archiv., Bd. 213, p. 529.

BUNTING (1911). The normal differential leucocyte count. Amer. Journ. of Med. Science, Nov.

BUSHNELL and TREUHOLZ (1908). Arneth method in the study of pulmonary Tuberculosis. Med. Rec., 73, p. 471.

BUSSE (1910). Phagozytose und Arneth's ches Blutbild. Münch. Med. Wschft., No. 2, p. 70.

CHAMBERLAIN and VEDDER (1911). A Study of Arneth's nuclear classification of the neutrophiles in healthy adult males and the influence thereon of race, complexion, and tropical residence. The Philippine Journ. of Science. Vol. VI. p. 403.

EHRLICH and LAZARUS (1910). Anaemia. London.

ESSER (1906). Das neutrophile Blutbild beim natürlich und Künstlich genährtem Säugling. Münch. med. Wochenschrift, No. 34.

HEWES, H. F. (1904). Standard records of the leucocytes in normal blood for reference in clinical work. Boston Med. and Surg. Journ., Dec., p. 705. (Rev. Folia Haematol., Vol. II, p. 325, 1905).

ORLAND (1907). Beiträge zur Untersuchung des neutrophilen Blutbildes beim gesunden und Kranken Säugling. Inauj. Dissert. Bonn, and Med. Klinik, No. 49.

PAPPENHEIM, A. (1909). Folia haematologica, Vol. VII, p. 85.

PAULICEK, E. (1907). Zur qualitativen Blutuntersuchung nach der von Arneth angegebenen Methode. Folia haemotologica, Vol. IV, p. 751.

SCHILLING-TORGAU (1911). Kritik der Arneth chen Lehre von der verschieburg des leucocytären Blutbildes und Wertung ihrer Klinischen Anwendbarkeit. Folia haematologica Archiv., Vol. XII, No. 1, p. 130.

SIMON, C. E. (1907). Clinical Diagnosis, 6th Ed., pp. 76 and 81.

THE OCCURRENCE OF LEAD POISONING AMONGST NORTH QUEENSLAND CHILDREN

BY

A. BREINL

AND

W. J. YOUNG

FROM THE AUSTRALIAN INSTITUTE OF TROPICAL MEDICINE

(*Received for publication 28 August*, 1914)

TWO CHARTS

INTRODUCTION

In 1892, Lockhart Gibson, Wilton Love, Jeffris Turner and others drew attention to a disease occurring amongst children living in the neighbourhood of Brisbane, which they attributed to lead poisoning.

The symptoms of the disease in the ten children mentioned was a paralysis of certain groups of muscles, namely, the extensors of the fingers, the tibialis anticus and the long extensors of the toes, and the muscles which form the bulk of the thenar prominence, the abductor opponens and flexor pollicis brevis.

The electrical examination in three cases revealed a well-marked reaction of degeneration in the paralysed muscles. Besides the paralysis, an anaemia of varying degree was observed; the characteristic blue line in the gum was only rarely seen, and when present occurred opposite a few isolated teeth only. Pains in the limbs and spasmodic contractions of the calf muscles were most uncommon. None of the cases complained of colic, but four cases gave a clear history of gastrointestinal seizures and constipation. The diagnosis was based on the typical distribution of the palsy, and the presence, in two cases, of distinct traces of lead in the urine after the commencement of the administration of potassium iodide. The question of the source of the poisoning was left in abeyance.

Volume VIII April, 1914 No. 1

ANNALS
OF
TROPICAL MEDICINE AND PARASITOLOGY

ISSUED BY

THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE

Edited by

PROFESSOR J. W. W. STEPHENS, M.D. Cantab., D.P.H.

PROFESSOR R. NEWSTEAD, M.Sc., F.R.S., A.L.S., F.E.S., Hon. F.R.H.S.

PROFESSOR WARRINGTON YORKE, M.D.

AND

PROFESSOR SIR RONALD ROSS, K.C.B., F.R.S., M.D., F.R.C.S.
MAJOR I.M.S. (RET.)

Editorial Secretary
DR. H. B. FANTHAM
School of Tropical Medicine
The University