Clinical Observations on the Blood of the Insane. By S. RUTHERFORD MACPHAIL, M.D. Edin., Assist. Med. Supt., Garlands Asylum, Carlisle; being the Essay to which the prize of £10 10s., together with the bronze medal of the Association, was awarded in 1884.

The older writers on Insanity including Pinel, and Esquirol, believed that functional disturbances of the higher nervous centres were the chief factors in producing mental disease. Whether this is the case or not, and whether functional disease of the brain may exist without appreciable change of structure, there can be no question that the quantity and quality of the blood circulating through the higher nervous centres affect their functions in an important manner.

First as to quantity. According to Bucknill and Tuke* the effect of blood on the brain, when in excess, is that of lethargy, while a diminution of its quantity is productive of syncope and unconsciousness. Both these conditions, described as congestion and anæmia, may be due to temporary irregularities in the supply of blood to the brain, and may pass away without leaving any ill consequences behind, although their frequent occurrence acting on a highly susceptible organism may produce minute changes, manifesting themselves by various morbid mental phenomena. Andral, quoted by Bucknill and Tuke, lays down the axiom that "in every organ the diminution of the normal quantity of blood which it should contain produces functional disturbances, as well as the presence of excessive quantity of blood." It is difficult to determine whether these alterations in the quantity of blood circulating through the brain are local or general in character, but it seems reasonable to premise that both conditions are possible. It is not, however, sufficient to refer mental symptoms to hyperæmia in one case and to anæmia in another, for they themselves are frequently mere effects. In this connection the importance of the vaso-motor system must not be overlooked. Maudsley† believes that all active emotions are accompanied by changes in the circulation, through vaso-motor inhibition, and that

* "Psychological Medicine," page 586. † "Pathology of Mind," page 193.

vascular disturbances may be produced by them within the brain very much as blushing of the face and neck is produced by shame. Irregularity in the blood-supply of the brain produces a condition of irritation of that organ, though this need not necessarily go on to actual mental disease. The sluggishness of the circulation in the extremities of many asylum patients, especially demented, is very noticeable; and if this be any criterion of the state of their cerebral circulation, there is little difficulty in accounting for their mental symptoms.

The quality of the blood may be impure from some error in the processes of digestion, assimilation, or excretion. To take the most common instance of this, the presence of bile in the blood, even in healthy and strong-minded individuals, gives rise to gloomy forebodings and melancholy conceptions. Also uric acid in the blood of a gouty patient causes an irritability of temper which is sometimes so severe that it passes into an outbreak of maniacal excitement. Arguing from such well-known facts as these, and knowing the effects of certain drugs, as chloroform producing anaesthesia, nitrous oxide gas producing laughter, and alcohol producing hilarity and excitement, we must admit that the brain may be affected through its nutrition, or, in other words, through the quality of its blood-supply.

Of course the affections of the nervous system must not be approached from the vascular side only, but this aspect of the question is worthy of attention. In this connection it is interesting to remark that nervine sedatives are more or less vascular depressants, and that nervine tonics tend to raise the blood pressure.*

The bodily symptoms of insanity have had a fair share of attention devoted to them in late years. If we believe, as many do, that mental disease can be regarded by the physician only as abnormal manifestation of the psychical function of the brain due to bodily conditions, it is desirable to investigate thoroughly the physical condition of all patients who are mentally affected.

Patients admitted into asylums may be broadly divided into three classes—

(1) A small group consisting chiefly of cases of recent insanity with no ostensible symptoms except those of mental derangement.

* "Handbook of Treatment," Fothergill, page 509.

(2) A large group with well-marked symptoms of bodily disease which can be directly connected with the psychical symptoms.

(3) A group, intermediate in size, suffering from general debility or want of tone of the system, and in whom no organic or absolute physical disease can be detected.

Clouston* describes this third group as "such a lowering of the general condition of the body that it must be reckoned truly abnormal. This condition of body undoubtedly precedes certain forms of insanity and accompanies them. That there is no specific disease in most of such cases is proved by the recovery of many of them, and by the long life of many of the others." In 100 patients whose mental symptoms had lasted under six months, Dr. Clouston found 13 cases of this description. I have gone over the records of the last 500 patients admitted into this asylum, and I find that 47 men and 62 women of that number were in weak bodily health on admission, and in whom no specific disease was discovered after repeated physical examination. This excludes all old people over 65 years of age. Of these 109 cases 23 men and 29 women, or 47·7 per cent. of the total number, have been discharged recovered.

Griesinger† goes further than Clouston, and says that many inmates of asylums die from anæmia and marasmus without any serious local affection except perhaps a slight degree of atheroma of the vessels being discovered.

Chiefly with the object of ascertaining whether poverty of blood plays the same weighty predisposing part in the production of insanity that it does in the production of other diseases, I have made a series of observations, extending over a period of sixteen months, on the blood of insane patients. This is a field of clinical investigation which, so far as asylum-physicians are concerned, has as yet had little attention paid to it, although in the case of many diseases, physicians have been helped to a right diagnosis, and have derived many indications for treatment from a systematic examination of the blood.

The morphological elements of the blood in the normal state are the red and white corpuscles; by the aid of the

* "The Bodily Symptoms of Insanity." "Practitioner," 1871, Vol. ii., page 12.

† "Mental Diseases." New Sydenham Society's Translation, page 437.

microscope small granules floating in the serum may also be recognised, and when coagulation has taken place, a reticulum of fibrin. The colouring matter of the red corpuscles, or hæmacytes, which gives to the blood its red colour, is called hæmoglobin.

In examining the blood for clinical purposes there are three points to be considered—(1) Its richness in corpuscles; (2) The richness of the corpuscles in hæmoglobin; and (3) The amount of water diluting the corpuscles. Instruments of considerable precision, called respectively the Hæmacytometer and Hæmoglobinometer, have been devised for ascertaining the richness of the blood in corpuscles and in hæmoglobin. Inasmuch as the number of corpuscles present in any given bulk of blood is merely an expression of the proportion of corpuscles to the amount of plasma, variations in the number of hæmacytes counted might be caused by an increase or decrease in the quantity of plasma occurring, while the actual number of the corpuscles is stationary. Unfortunately we have as yet no means for determining this third factor during life, and this diminishes the value of results obtained by the above-named instruments.

All the methods devised for ascertaining the corpuscular richness of the blood consist in making a definite dilution of a certain quantity of blood, and counting the corpuscles in a certain volume of that dilution. Potain, Malassez, and Hayem have each devised an instrument adapted for clinical purposes, but their methods are cumbrous and inconvenient. The instrument I have used is Dr. Gower's hæmacytometer,* which is more simple for ordinary use, and is accurate enough for all practical purposes.

To eliminate as far as possible any instrumental error in the numerations, I invariably counted more than one drop of the mixture, and in the case of any marked discrepancy three or four drops have been examined and the mean of all the observations taken. The same instrument has been used throughout, and the blood to be examined was drawn from the finger without pressure.

The amount of hæmoglobin in the blood is ascertained by means of the hæmoglobinometer. The method consists in diluting a known volume of blood and comparing it with a

* For full description see "Lancet," 1st December, 1877, and "Practitioner," 1878, page 1.

standard solution. The average amount of hæmoglobin in each corpuscle is represented by a fraction of which the numerator is the percentage of hæmoglobin, and the percentage of red corpuscles the denominator. The observations with the hæmacytometer and the hæmoglobinometer were made simultaneously. Each observation took over half an hour to complete, and in not a few of the cases considerable difficulty was experienced in inducing patients to submit to the necessary puncture. The total number of observations represented by this paper is 420.

It is obvious that limitations of time and opportunity must narrow the scope of any experimental observations in such an extensive field of investigation; but the observations, which up to this time I have made may serve as an introduction to the further study of this important and interesting subject.

The special points I have endeavoured to determine are:—

- (1) What is the amount of hæmoglobin and of red and white corpuscles in the normal condition of the blood?
- (2) What is the condition of the blood in the class of patients who constitute the chronic inmates of asylums?
- (3) Is the blood deteriorated in well-marked types of insanity, as General Paralysis and Epilepsy?
- (4) Do variations occur in the blood of patients subject to attacks of periodic excitement?
- (5) What is the state of the blood in patients when admitted?
- (6) What is the state of the blood in patients who recover?
- (7) What are the effects of various blood tonics on cases of recent insanity?
- (8) Can any definite conclusions be arrived at from these observations which would be of practical value in the curative treatment of the insane?

I.

As a basis from which to work I first of all made a series of observations upon 30 cases of persons in presumably perfect health of body and mind. These, 15 males and 15 females, were selected chiefly from officials of the Asylum, and their respective ages ranged from 22 to 38 years. I give the results in a tabular form, showing the percentage amount of hæmoglobin and hæmacytes, and the proportion of white to red corpuscles in each instance.

A Table giving Percentage amount of Hæmoglobin and of Hæmacytes, and proportion of White to Red Corpuscles in the blood of 15 healthy persons of either sex.

HEALTHY MALE BLOOD.				HEALTHY FEMALE BLOOD.			
No.	Percentage of Hæmoglobin	Percentage of Hæmacytes.	Proportion of White to R. B. C.	No.	Percentage of Hæmoglobin	Percentage of Hæmacytes.	Proportion of White to R. B. C.
1	100	99·9	1 to 440	1	85	94·7	1 to 360
2	96	103·2	1 to 350	2	78	91·5	1 to 310
3	90	101·4	1 to 450	3	90	96·7	1 to 420
4	96	98·8	1 to 360	4	90	94·	1 to 280
5	90	99·2	1 to 430	5	88	90·9	1 to 360
6	100	102·4	1 to 480	6	80	93·2	1 to 380
7	90	99·	1 to 380	7	85	94·1	1 to 220
8	105	99·8	1 to 420	8	78	92·3	1 to 280
9	85	95·2	1 to 380	9	95	95·9	1 to 360
10	100	102·6	1 to 480	10	82	96·1	1 to 480
11	100	103·4	1 to 420	11	84	92·	1 to 380
12	95	102·5	1 to 340	12	88	91·7	1 to 430
13	95	101·9	1 to 440	13	80	89·8	1 to 210
14	104	105·1	1 to 510	14	90	95·2	1 to 290
15	95	102·7	1 to 450	15	86	94·8	1 to 460
Averages.	96	101·14	1 to 442		85·2	93·52	1 to 348

The average percentage of hæmoglobin is 96 in men and 85 in women. The variations are considerable, and there are greater fluctuations between the highest and lowest percentages in the observations in males than in those of females. The average number of red blood corpuscles per cubic millimetre is in men 5,075,000; and in women 4,676,000, or, expressing this in percentage form, male healthy blood, 101·14; female, 93·52. These results are rather higher than those of Laache,* who, in an analysis

* "Die Anæmie" von S. Laache. Christiania, 1883. Reviewed "Medical Times," 1884, page 28.

of 60 cases, found the mean to be 4,970,000 per cubic millimetre for men, and 4,430,000 for women (99·4 and 88·6 per cent.). Speaking generally, we may represent the amount of red corpuscles in healthy male blood by 100, in females by a slightly lower percentage. In my observations the average proportion of white to red corpuscles is 1 to 442 for males; 1 to 348 for females. There were variations in the individual percentages and proportions, but these call for no special comment.

In the observations with the hæmacytometer a diluting fluid of constant strength, that recommended by Gowers, (sodæ sulph. grs. 104, acid acet. 3i, aquæ destill. ad 3iv) was employed. This solution has some effect in changing the shape of the corpuscles, but has no influence on their diameter. The size of the red discs varies considerably, even in healthy blood. Hayem, quoted by Dr. Norris,* says that 75 per cent. of the corpuscles are of average size, 12 per cent. small, and 12 per cent. large. This is an important point, for it is obvious that if the small forms are more numerous, the average corpuscular diameter is lower than normal, and if there be a number of large cells in the blood under observation the corpuscular diameter of the cells is relatively increased. In my observations I simply made a general note of the relative size of the corpuscles in each instance, and did not attempt to go into detail. In healthy male and female blood the large majority of the hæmacytes were of an average uniform size, while large and small forms collectively did not exceed 10 per cent. of the total number. In two instances in the case of men I noted that large-sized corpuscles were more numerous than usual, and the blood of one female contained about 50 per cent. of blood discs below the normal size. In none of these cases, however, did the percentage of hæmacytes vary much from the normal standard.

Small granule-cells were observed in fully two-thirds of the cases. These small particles, called by some "hæmatoblasts," are a normal constituent of the blood, and, unlike the ordinary red blood corpuscles, are stained red by carmine. It is stated that they become relatively more numerous in blood which is undergoing recuperation. A few corpuscles were crenated, but I am not prepared to say whether this crenated condition of the cells was influenced by the diluting solution employed.

* "The Physiology and Pathology of the Blood," page 165.

II.

I adopted the following means for ascertaining the condition of the blood in the class who form the unrecovered residuum of asylum-patients:—I took 40 demented or chronic maniacs in average bodily health, and had them weighed periodically. These patients had been resident in the asylum for periods varying from four to 22 years, and none had been under medical treatment for some years previously. I give the series of observations in tabular form, dividing the cases into four groups according to age. I submit also a few remarks on each group.

B. Tables showing percentage of Hæmoglobin and Hæmacytes in the blood of a series of Demented at three different periods, and Weights at four different periods.

TABLE I.—TEN DEMENTED BETWEEN 20 AND 30 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different Periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '82.	June, '83.	Nov, '83.	Mar, '84.	June.	Nov.	Mar.	Average.	June.	Nov.	Mar.	Average.
1	6 yrs.	143	146	146	146	75	70	74	73	96·8	97·4	96·9	97
2	5 yrs.	134	130	128	129	64	66	65	65	95·7	90·8	92·2	92·9
3	8 yrs.	153	150	144	147	62	64	62	62·6	89·7	85·9	87·8	87·8
4	4 yrs.	160	164	162	162	65	68	65	66	88·6	90·1	89·5	89·4
5	4 yrs.	156	154	156	155	62	68	66	65·3	95·6	94·5	94·2	94·7
6	7 yrs.	158	156	155	155	70	68	62	66·6	94·7	93·3	94·1	94
7	5 yrs.	149	151	152	149	68	64	64	65·3	86·2	85·1	86·8	86
8	11 yrs.	139	144	146	145	68	68	68	68	87·7	89·2	88·5	88·4
9	7 yrs.	133	125	126	126	55	55	55	55	82·7	81·8	82·2	82·2
10	4 yrs.	164	159	158	158	70	72	72	71·3	91·4	92·1	91·8	91·7
Avg.	6·1	148·9	147·9	147·3	148·03	65·9	66·3	65·3	65·8	90·91	90·02	90·40	90·44

The period of residence of the patients varies from four to 11 years. Their weights range from 126 to 164 lbs., and it will be observed that the weights, taken at four different periods in 26 months, show slight variation in individual instances, the difference never exceeding 7 lbs., while the average weight for the 10 patients at each period of the

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year is very uniform. The percentage of hæmoglobin is considerably below normal, and varies from 55 to 75 per cent., as compared with 96, the normal standard. While the amount of hæmoglobin varied in individual cases, the percentage in each is very uniform at the three different periods, thus showing that the season of the year has little effect on the quantity of hæmoglobin. Although the lowest percentage of hæmoglobin was observed in the lightest patient, it is not clear that we are justified in assuming any relation between the variations in weights and variations in the percentage of hæmoglobin, for in two of the cases a higher percentage was registered during the period when the weight was lowest. The percentage of hæmacytes varies from 3·7 to 19·3 below normal, while the average is fully 10 per cent. below the standard. As in the case of the hæmoglobin, there are variations in the absolute and relative averages at different seasons of the year; but this does not occur in such a precise form as to enable one to make any deductions.

TABLE II.—TEN DEMENTS BETWEEN 30 AND 40 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '82.	Nov, '83.	Feb, '84.	May, '84.	Nov.	Feb.	May.	Average.	Nov.	Feb.	May.	Average.
1	18 yrs.	166	162	167	164	70	70	70	70	92·8	92·6	91·8	92·4
2	14 yrs.	148	150	148	148	70	70	72	70	92·1	91·7	92	91·9
3	11 yrs.	139	133	136	136	68	74	70	70·6	89·2	92·0	90·7	90·6
4	9 yrs.	138	138	139	138	66	70	64	66·6	86·7	90·9	87·8	88·4
5	14 yrs.	170	166	166	164	66	68	68	67·3	90·5	86·1	88·4	88·3
6	21 yrs.	151	150	147	148	74	68	72	71·3	93·9	92·5	92·8	93
7	9 yrs.	121	116	120	119	65	64	65	64·6	86·5	83·8	85	85·1
8	6 yrs.	135	129	130	128	60	58	62	60	87·4	89·7	87·9	88·3
9	4 yrs.	152	152	150	152	75	70	72	72·3	89·2	90	88·7	89·3
10	11 yrs.	138	135	130	124	58	60	60	59·3	85	87·2	85·6	85·9
Avg.	11·5	145·8	143·0	143·3	142·1	67·2	67·2	67·5	67·3	89·33	89·65	89·07	89·35

It is worthy of remark that we have diminution of the percentage of corpuscles with an increase of hæmoglobin. The

converse likewise occurs, and we have a decrease in the percentage of hæmoglobin and an increase in the number of corpuscles.

The average period of residence of the patients in this group is $11\frac{1}{2}$ years. There is a greater variation in the weights at different periods than in the previous group, one patient alone losing 14 lbs. in 29 months, while the average loss of weight for the 10 patients during that period is 3.7 lbs. The percentage of hæmoglobin is very uniform, both in the individual cases and in the average of each period. The average amount of hæmoglobin is slightly higher than in the first group. On the other hand, the average number of hæmacytes is 1.1 per cent. lower, while the variations in the averages for each period of the year are more uniform, and the individual averages are less uniform than in Table I. There appears to be no relation between variation in weight and increase or decrease in the percentage of hæmoglobin and hæmacytes.

TABLE III.—TEN DEMENTS BETWEEN 40 AND 50 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '82.	Dec, '83.	Mar, '84.	May, '84.	Dec.	Mar.	May.	Average.	Dec.	Mar.	May.	Average.
1	15 yrs.	160	158	156	154	75	70	70	71.6	96.1	91.7	92.5	93.4
2	7 yrs.	158	150	148	148	65	68	65	66	89.2	96.1	92.2	92.5
3	20 yrs.	140	133	132	132	62	64	64	63.3	90.8	89.5	90.8	90.3
4	5 yrs.	150	154	150	150	78	75	75	76	95.1	91.5	91.9	92.8
5	6 yrs.	152	151	154	154	65	65	68	66	91.7	94.1	92.7	92.8
6	17 yrs.	164	158	162	161	65	68	68	67	88.9	91.7	87.9	89.5
7	22 yrs.	140	144	139	138	64	65	65	64.6	88.9	90.2	89.1	89.4
8	18 yrs.	184	190	190	196	64	65	64	64.3	87.8	89.2	88.1	88.3
9	22 yrs.	154	154	152	150	58	55	58	57	79.3	79	80.9	79.7
10	15 yrs.	140	137	139	136	62	65	60	62.3	84.6	85.7	83.9	84.7
Avg.	$14\frac{1}{2}$	154.2	152.9	152.2	151.9	65.8	66.0	65.7	65.8	89.24	89.87	89	89.37

The special points in this table are : An average period of residence of $14\frac{1}{2}$ years ; an average loss of weight of 2.3 lbs.

in 29 months; an average percentage of hæmoglobin similar in amount to that in Table I., but less than in Table II.; a lower percentage of red corpuscles than in either of the previous groups.

TABLE IV.—TEN DEMENTS BETWEEN 50 AND 60 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '83.	Dec, '83.	Mar, '84.	May, '84.	Dec.	Mar.	May.	Average.	Dec.	Mar.	May.	Average.
1	14 yrs.	172	176	174	175	65	68	68	67	87	86.9	87.8	87.2
2	22 yrs.	118	108	108	110	74	68	70	70.6	87.4	87	88.9	87.7
3	12 yrs.	156	155	*—	—	66	—	—	66	87.7	—	—	87.7
4	22 yrs.	158	154	148	152	68	70	65	67.6	87.8	87.1	86.6	87.1
5	13 yrs.	172	168	172	173	55	60	60	58.3	88.4	87.3	87.8	87.8
6	7 yrs.	163	158	156	158	68	70	70	69.3	87.7	86.9	86.5	87
7	15 yrs.	174	176	172	172	70	70	70	70	86.3	85.9	86.7	86.3
8	22 yrs.	148	148	154	149	70	72	70	70.6	86.7	87.2	87.2	87
9	22 yrs.	175	171	170	166	60	58	60	59.3	87.4	86.9	85.4	86.5
10	22 yrs.	138	143	145	147	58	60	58	58.6	87.8	89.2	88.6	88.5
Avg.	17.1	157.4	155.7	155.4†	155.7†	65.4	66.2†	65.6†	65.73	87.42	87.15†	87.27†	87.28

* Died of Pneumonia, March, 1884.

† Average of Nine Observations.

This table is incomplete, inasmuch as one of the patients died of an intercurrent attack of pneumonia, and his blood was examined only on one occasion. The table, however, brings out more forcibly the diminution in the average percentage of red corpuscles noted in the third group.

The proportion of white to red corpuscles was also ascertained, but as they showed so little variation from the normal standard, I have not given the results in the tables.

The relative size of the corpuscles was fairly uniform. There was an almost complete absence of small forms, though corpuscles of large size were observed in several of the cases. Small granule-cells were seen in only six of the 40 cases under observation, and when they were detected they were ill-defined, and did not occur in groups, as is the case in normal blood.

Of these 40 patients, six in the first group, five in the second group, three in the third group, and four in the fourth group had a course of ferruginous or nervine tonics during the earlier period of their residence in the asylum, but in no instance had tonics been administered during the three years preceding the observations.

Four patients in the first group, three in the second, and one in the third group were known to be masturbators, and it is worthy of remark that the average percentages of hæmoglobin and of hæmacytes in these cases were rather below the percentages in the tables in which the observations on their blood is detailed. With the object of seeing whether this was merely a coincidence, I examined the blood of four other patients known to be addicted to masturbation; and, without entering into detail, I am in a position to state that the percentage of hæmacytes in the patients examined was considerably below the normal standard, while the amount of hæmoglobin was also diminished, though to a less extent.

Summarising the results of my observations on the class of demented or chronic maniacs, an examination of the foregoing tables appears to warrant the following conclusions:—

- (1) The percentage of hæmoglobin is considerably below the normal standard, and does not appear to be influenced by the age of the patients.
- (2) The percentage of hæmacytes is likewise diminished, and this diminution progresses with the age of the individual.
- (3) The proportion of white to red corpuscles is normal.
- (4) The blood is deficient in hæmatoblasts.
- (5) In the patients over 30 years the weight decreases, but this decrease does not appear to influence the relative percentage of hæmoglobin and of hæmacytes.
- (6) The period of residence and the season of the year do not affect the absolute proportional averages of the constituents of the blood.

(To be continued.)