Drop-methods of counting the cells of the cerebro-spinal fluid : the relation of the cell-count to the Wassermann reaction / by R. Donald.

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BY

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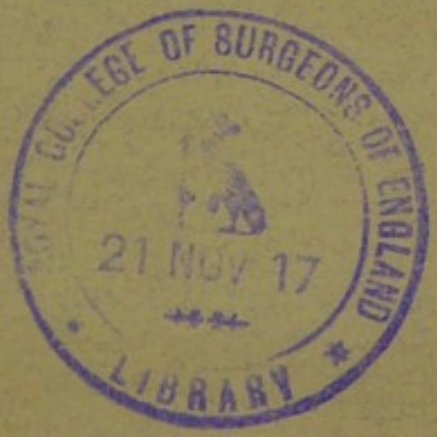

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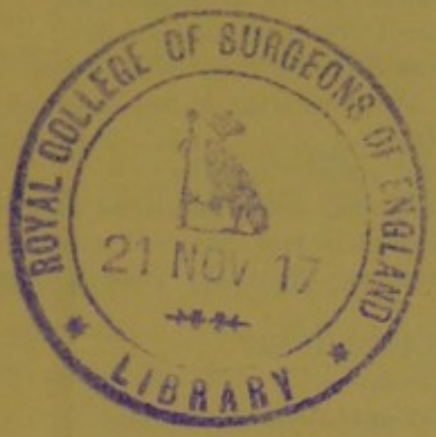

DROP-METHODS OF COUNTING THE CELLS OF THE CEREBRO-SPINAL FLUID—THE RELATION OF THE CELL-COUNT TO THE WASSERMANN REACTION.

By R. DONALD, B.Sc. (N.Z.), D.P.H. (Oxf.).

(Bacteriological Laboratory, London Hospital—Prof. W. Bulloch, M.D., F.R.S.)

Plan of the Article.

Results Obtained.

Notes on the Tables.

The Tables.

In connection with the research on "parasyphilis" now being made by Drs M'Intosh, Fildes, Head, and Fearnsides[1] more than 260 cell-counts have been done by the writer, during the past year or so, on the cerebro-spinal fluids submitted simultaneously with the sera to the Wassermann test by Dr Fildes.

An interim[2] report on the first hundred cell-counts and Wassermann findings was published in September last. A considerable number of cell-counts have since then been similarly done, some on patients that had been repeatedly so tested before September. The results of the 260 cell-counts (collated, through the courtesy of the authors named,[1] with their Wassermann findings, &c.) are of sufficient interest to justify a further report.

[1] M'Intosh, Fildes, Head, and Fearnsides, Preliminary Report, *Proceedings* of the Neuropathological Section of the XVIIth International Congress of Medicine, London, 1913. Extended Report, *Brain*, Vol. xxxvi., Part i., July 1913, and following numbers.

[2] Donald, *Folia Hæmatologica*, xvii. (1913), 139-166.

The drop-film method of cell-counting, used throughout this research, was worked out in counting the earlier specimens of cerebro-spinal fluids.

Other cell-counting methods may first be outlined. They are practically of three types.

Methods of the **first type**, comprising the French method and Alzheimer's method, use centrifuging to collect the cells into a thick deposit.

By the **French method** a small, rather uncertain, quantity of the deposit is dried on a slide, stained, and examined.

By **Alzheimer's method** the c.s.f. is dropped into alcohol before centrifuging. The resulting small mass of coagulum is then embedded in celloidin, and sections from this are stained.

These methods show the kinds of cells present in the centrifuged deposit, and not the absolute cell-counts, but merely an empirical indication of the relative cell-counts of such c.s.fs. as have been examined by exactly the same technique. Even as regards the kinds of cells present, some cells, as will be shown below,[1] may be lost through centrifuging, which also probably more or less upsets the uniform distribution of the cells. Moreover in Alzheimer's process the red cells will be destroyed by the alcohol, whereas, whether due to the puncture or due to previous hæmorrhages, they ought to be estimated. Indeed most workers supplement the French result or the Alzheimer result by a chamber count.

Methods of the **second type** give by means of counting chambers an estimate of the total cell-count of the c.s.f. The principal difficulty lies in distinguishing with ease and certainty the various kinds of cells in the chamber.

For c.s.f. one or even two fills of the Fuchs-Rosenthal counting chamber, the capacity of which is about 3 c.mm., is none too great a quantity to count through. The heavy cover-glass, 0·4 mm. thick, and the deep counting chamber, 0·2 mm., necessitate a low power objective, while the thickness of the counting chamber floor hinders critical illumination. Now if the c.s.f. be examined unstained, as recommended by one worker,[2] narrow angle illumination must be employed, so these just mentioned three circumstances combine to call for such special skill and such patient effort as few can command.

[1] See p. 339.

[2] Frenkel, *Neurol. Centralbl.*, 1912, Nr. 31, S. 1085.

If, however, the c.s.f. can be satisfactorily stained in the counting apparatus, the process of observation will be considerably facilitated. A process that while staining the white cells destroys the red cells may at once be dismissed as misleading, unless when used by an experienced worker. The only staining process that promises facility in distinguishing clearly among the various types of cells, white and red, in the counting chamber is that recently described by Dunzelt.[1] This process, however, is described as requiring some considerable time for the staining of c.s.f. cells—indeed more than half an hour for the staining of the red cells in ordinary diluted blood. So, probably, several chambers would have to be provided if half a dozen c.s.fs. had to be dealt with in a sitting.

Suggested Drop-Chamber Method.—For the simultaneous mounting in chambers of any number of c.s.fs., to be examined alternately or repeatedly, *e.g.*, for comparison of the cells, there may here be suggested a simple and efficient device, suitable also for dark-ground illumination.

For each chamber there is taken an ordinary clean slide of the thickness suitable for the dark-ground condenser, and to its under side is applied a drop of immersion oil. Then on the upper side are placed a pair of slips of ordinary cover glass about three-quarter inch apart. Midway between these slips is deposited one Morse 80 drop[2] of c.s.f. Then without delay there is lowered on to the drop a clean ordinary cover glass, say 1 by $\frac{7}{8}$ in., to rest on the placed slips. Vaseline may be used to steady the parts of this simple chamber, as also to prevent drying, especially if the drop (deposited on a spot previously wetted with $HgCl_2$ and then dried) is to be kept some little time. It is well that the two slips be not grossly unequal in thickness or the liquid will be drawn into the thinnest part of the chamber.

Of course, the thinner the equal supporting slips are chosen (from cover glasses 0·10 to 0·20 mm. thick), the larger proportionately is the area of the spread-out drop. The volume of a Morse 80 drop of average c.s.f. is $7\frac{1}{2}$ c.mm. Accordingly, the area of the drop with supporting slips 0·15 mm. thick is 7·5/0·15, *i.e.*, 50 sq. mm.

Such a chamber is well adapted for dark-ground illumination,[3]

[1] Dunzelt, *Münchener med. Wochenschrift*, 1913, S. 2616. [2] See p. 340.

[3] Ruled counting chambers have too thick a floor for use with ordinary dark-ground condensers.

and the whole area may easily be scanned with a medium-power objective and a moderately high eyepiece. But the chamber is easily within the working range of a 4 mm. objective, and practically within the ordinary collar-correction range, if thin cover glasses and thin supporting slips are used.

Of current methods of cell-counting, there remains to be described a **third type,** represented by Geissler's ruled slide method, devised to give in a stained film both a numerical and a qualitative count. On a space 20 by 20 mm. ruled with parallel lines on an optically finished slide, 40 c.mm. of the cerebro-spinal fluid is deposited by means of an accurately graduated capillary pipette. After drying and heating in an incubator, the film is fixed by alcohol-ether mixture (one to two minutes), and is stained with Pappenheim-Unna stain or with Leishman stain, then soaked carefully in water and gently "blotted." Various other workers had estimated the cell-count, by counting through some subjectively chosen fields in dried films from a known volume of c.s.f. But Geissler makes an "objective" estimate by counting through the whole 40 c.mm. film.

Unfortunately, this method demands very special skill. Ordinary skill can hardly stain and wash such films without considerable loss of cells. Moreover, in examining, as recommended, uncovered films with a dry lens, the details of the cells will be imperfectly made out unless the lens is specially constructed. Thirdly, the slide is expensive, and the preparation cannot be kept for reference, but the slide has to be cleaned off, with special care, till under the microscope it is seen to be quite free from cells.

The drop-film method of cell-counting described in this article avoids some of the disadvantages of the above-mentioned methods, and combines most of their advantages in a simply-prepared permanent preparation.

On each of any number of ordinary slides, a couple of separate drops of the c.s.f. are easily and accurately deposited, and then dried and fixed. Next the slides are soaked for a few seconds in dilute collodion, and dried. Thus are obtained drop-films that are practically thin collodion sections at most only one dried cell in thickness. These films can now at leisure be stained, *e.g.*, Giemsa, or Leishman, and Pappenheim-Unna, washed, and dried, without the loss of even a bacterium from the film. A

cover glass attached with clear soft paraffin completes a permanent preparation that gives easily an accurate cell-count, and at the same time a good cell-picture. The variously stained preparations are permanent for reference and for comparison. The method uses no special apparatus and avoids centrifuging.

Some **details of the drop-film method** may now be given. Other details are given in a preliminary article in *Folia Hæmatologica*.[1]

First may be mentioned some **precautions taken**.

The c.s.fs. were **counted** as soon as possible after puncture. But a good many were not available until a day or so old. However, by counting early in the research a number of c.s.fs. of various types when fresh, and then again when twenty-four hours old, it was found that at ordinary laboratory temperatures the loss of cells in the twenty-four hours was negligible,[2] if the cells now swollen in degeneration were stained and counted in.

Even after being kept nearly a week at laboratory temperature, averaging 15° C., aseptic specimens of c.s.f. were found to yield a useful indication of pleocytosis, especially when the preparation was stained strongly and clearly with Giemsa or with Leishman stain. For instance, the c.s.f. of F. S., case 134, taken on the evening of May 11, 1914, showed next day thirty-one cells per c.mm. Another tube of the same specimen, kept at laboratory temperature averaging 15° C. till May 16, 1914, showed fourteen cells per c.mm., 75 per cent. of these being, indeed, considerably swollen. Similarly a c.s.f. left by mistake undelivered for fully six days at about 15° C., was on April 15, 1914, found to have forty-two cells per c.mm., about 50 per cent. of them being swollen. (J. W., case 80. The fresh c.s.f. had probably over a hundred cells.)

So the c.s.fs. not available for a day or so could thus be reliably counted, especially as for most of the time they were kept in an ice-safe.

These **swollen cells** were, by strong clear Giemsa or Leishman staining, found to arise in large numbers in many c.s.fs. a day or so old, from the degeneration of cells, mononuclear and polynuclear, that were unswollen in the fresh fluid. Also similar swollen cells were seen to occur in considerable numbers in some freshly drawn

[1] Donald, *Fol. Hæm.*, xvii. (1913), 139-166.

[2] Donald, *Fol. Hæm.*, xvii. (1913), 144. Contrast Bigelow, *Amer. Journ. of Insanity*, lxvii. (1911), 745.

c.s.fs.,[1] indicating the activity of cell passage into the c.s.f. The swollen cells have, accordingly, in this research been included in the total cell-count.

Centrifuging was avoided. It was found to be a disturbing factor difficult to deal with. Various c.s.fs.[2] were counted just before centrifuging, and again after centrifuging and agitating. The loss of cells after this treatment proved in the seven experiments to vary from a negligible quantity to 50 per cent. of the total count, the greatest loss being of the swollen degenerating cells.

Any **red cells** present were demonstrated, counted, and **allowed for**[3] according to a leucocyte count done, by a drop-film, on the patient's blood.

If the ordinary Fuchs-Rosenthal counting method be used, then, as Dreyfus recommends,[4] any considerable blood admixture must be avoided in performing the punction, or else not much reliance must be placed on the result. But an important c.s.f may at two consecutive punctions[5] happen to be the only blood-mixed specimen in half a dozen; and, if a suitable method is used, then, in spite of the red cells—nay, by their assistance—a practically reliable count is usually possible.

Clotted blood in the specimen, of course, prevents a count.

The technique of the drop-film method is as follows:—The **slides** are polished with a tuft of long-fibre grease-free cotton wool. Before receiving the drops of c.s.f. they are conveniently marked with a quill pen and, *e.g.*, a waterproof Indian ink. This writing, when later collodioned, stands either wetting or reasonable rubbing, though hardly both at once.

The specimen was shaken thoroughly just before measuring. Even fine gauzy blood-free clots could then be well distributed. A small square of washed smooth sheet rubber and the thumb are convenient for closing the tube in shaking.

[1] These findings are in line with those of Rous, of Rubinato, and of others; Rous, *Amer. Journ. Med. Science*, 1907, p. 567; Cornell, *Amer. Journ. of Insanity*, 1907-8, Vol. 64, p. 73; Villaret et Texier, *Journ. de Physiologie et de Pathologie générale*, 1905, Vol. 7, p. 841 (quoted by Rous); Rubinato, *Fol. Hæmatologica*, 1905, Bd. ii., S. 781; Turner, *Journ. of Mental Science*, July 1910, p. 485.

[2] Donald, *Fol. Hæm.*, xvii. (1913), 146, 147.

[3] Rous, *Amer. Journ. of Med. Science*, 1907, April, 567; Bigelow, *Amer. Journ. of Insanity*, lxvii. (1911), 745.

[4] Dreyfus, *Münchener medizinische Wochenschrift*, 1912, 2567.

[5] *E.g.*, A. C., case 84; *cf.* A. P., case 97, pp. 359, 361.

Measuring the c.s.f. was carried out by the easily calibrated dropping-pipettes, described in a recent brief communication [1] to the Royal Society.

Pipettes, with body about 4 cm. long, are drawn from glass tubing about 3 mm. external diameter heated in a large by-pass of a Bunsen burner. They are then pushed gently down into the suitable hole of a wire gauge until just arrested, and are cut off close to the upper surface of the plate. A convenient size, No. 80 of the Morse drill and wire gauge, is 0·34 mm. in diameter. A clean pipette of this size will, when held vertical, yield, at a drop-rate not faster than one per second, at ordinary laboratory temperature, a drop of average c.s.f. 1/135 c.c. in volume. The pipette-capillary must be quite clean, and must be carefully kept from contact with any trace of greasy matter. A fresh pipette is used for each specimen measured out.

The required slow steady rate of dropping can be conveniently attained by means of a small mercury-plunger tube.[2] In use, this is held at such an angle that the drop-rate is not faster than one per second. At all rates slower than one per second a dropping-point as small as 0·3 mm. in external diameter yields, of a given liquid at a given temperature, drops that are practically constant in weight.[3]

To **prevent settling down** of the cells in the pipette, during the depositing of a number of equal drops on slides, the pipette may be furnished with a bulb blown just above the capillary part before gauging. During the blowing, the pipette may be held at visual distance in a short rubber tube attached to a glass blowpipe. An almost closed U of clean copper wire dropped into the bulb will serve as a shaker without any ball-valve action.

[1] Donald, *Proc. Royal Society*, B., lxxxvi. (1913), 199.

[2] Made thus: A piece of clean dry tubing 12 to 15 mm. long and 1½ or 2 mm. bore, is opened out slightly funnel-shaped at each end, one end is tightly plugged with grease-free cotton wool, the tube is filled two-thirds with clean mercury, the other end is tightly plugged with cotton wool, and a short piece (about 3 cm.) of rubber tubing is fitted for attachment to the small pipettes.—Donald, *Lancet*, 1913, i., 1447.

To secure elastic air-tight fitting, the rubber tubing may have an external "sphincter" formed of several turns of a very small rubber ring. This "sphincter" is rolled back, the small pipette is inserted, and the sphincter rolled down over it.

[3] Ollivier, *Annales de chimie et de physique*, Sér. 8, Tom. x. (1907), p. 229; Donald, *Proc. Royal Society*, Series B, 1913, Vol. lxxxvi., p. 198.

The drops are conveniently **dried** at a temperature of about 37° C. on, *e.g.*, a copper fixing-plate covered with several folds of blotting paper.

The drop-films must be **fixed** by a water-free process, for any water treatment of such a crust (of much soluble salt with, often, few cells and a mere trace of albuminous matter) is, even after fixation, altogether too precarious.

Heat-fixation, if thorough, is simple and satisfactory.

Heat-fixation under observation served, in the case of one c.s.f., to suggest by the smell of ammoniacal fumes the presence of urea in the specimen. Further tests confirmed the suggestion.

Fixation by alcohol may be used for Pappenheim stain, but the alcohol must be absolute.

Next comes the **collodioning** of the drop-films. While they are still warm and dry, the slides are stood upright back to back for a few seconds in a jar of dilute collodion (1 part collodion B.P. with 9 parts alcohol and ether mixture). Then they are kept upright to drain and to dry, with the least possible injury to the collodion coating. Finally they are heated gently on the fixing plate to dispel the last trace of alcohol, and so to render the delicate film unlikely to be detached even by staining for tubercle bacilli.

Staining may be done as required. 1. For showing up all the cells, including the swollen cells, and the ordinary stainable micro-organisms, dilute Giemsa or Leishman stain may be left in a plump pool on the surface of the drop-film for about twenty minutes. A large pool of dilute, *e.g.*, Leishman, stain rocked from time to time will dissolve out the salts, and so prevent some of the stain pattern otherwise left. The use of warm stain in the incubator dissolves out the salts and stains the film in half the time. The stain is washed off with distilled water, containing about one part of acetic acid in 20,000. This is left on for two to five minutes, to remove the excess of stain adsorbed by the alkaline salts, and to bring up a distinct red in the erythrocytes. Then a rinse with the same, and gentle drying with blotting paper, pressed down by a soft pad of gauze and cotton wool. On the warm drop-film is melted the minimum quantity of clear soft paraffin, and the cover-glass is well pressed down. If the procurable soft clear paraffin is not optically fairly free from crystallising-out scales of

higher homologues, then the minimum quantity of thick paroline may be used. Such preparations are apparently permanent.

If any paraffin gets on to the upper surface of the cover glass it is not so easily cleaned off as cedar oil would be, to leave the cover glass bright and clear. The simplest plan is to put on a clean cover glass.

If the paraffin has for any reason to be washed off a Giemsa drop-film or other Romanowsky preparation, ligroin or other paraffin spirit of similar boiling point ought to be used, not an aromatic hydrocarbon such as xylol, which dissolves out some of the stain.

2. For showing up the finer structure of the cells, a drop-film similarly stained for about ten minutes may be mounted.

3. Any plasma cells present may be demonstrated by Unna-Pappenheim stain (pyronin-methyl green). About ten minutes at 37° C. will suffice. The stain is rinsed off with tap water and finished as described. This stain, of course, shows up in pyronin red any yeast cells, which, occurring singly in a Giemsa preparation, might by cursory low power observation be mistaken for micro-lymphocytes.

If Unna-Pappenheim staining is at all prolonged at 37°, the preparations ought to be kept under an air-tight Petri cover on a glass plate with a piece of cotton wool wet with alcohol and phenol to prevent loss of those substances.

4. To show up either gram-positive or tubercle bacilli the corresponding stains are used in the ordinary way on the film. After decolorising by 90 to 95 per cent. alcohol, the gram film is gently blotted and then dried before the watery neutral-red solution is used.

Before examination of the slide the collodion may be rubbed off the under side with a damp duster.

Examination of the stained drop-film may be done by powers of 120 diameters upwards. A good system of 240 diameters, if skilfully used, is sufficient for most differential counts.

Illumination is, of course, of great importance for rapid certain work. A **good simple lamp device** may be suggested. Vertical and on a level with the microscope mirror a small square, say 6 by 6 cm., of light opal glass in a simple lantern is strongly lighted by a 32 c.p. metal-filament lamp at the focus of a hemispherical mirror. Not the reflected light from the mirror,

but only diffused light from the front of the opal glass is used; so the mirror may be merely the silvered back-hemisphere of a spherical lamp, or even the bright tinned hemispherical bowl from a kitchen ladle cut to accommodate a pear-shaped lamp.

Very useful for counting a cell-rich film is a square eyepiece diaphragm with cross-lines. If the professionally-made appliance is not available, a substitute may be made of black paper with three or four parallel lines of a fine black hair laced, across the square opening, through needle holes, and fastened at its two ends by a touch of sealing-wax soldered down with a hot wire. Ruled glass eyepiece "diaphragms" do not improve definition.

But, at any rate for cell-poor films, the ordinary circular eyepiece diaphragm can be made to suffice. And even a very rich film may be reckoned up by measuring the number of times that the diameter of the circular field is contained in the mean diameter of the nearly circular drop-film, squaring this number, and then multiplying by the average number of cells per field.

A mechanical stage is practically essential.

Results Obtained by the Method.

In the patients on whom the 250 cell-counts were done lumbar punction was found advisable, either on account of probable meningitis without syphilis, or on account of possible meningitis with syphilis that was, in many cases, syphilis with evident nervous disease.

By the courtesy of the above-named authors, hitherto unpublished tables of Wassermann results have been lent as a setting for the cell-counts.

As the most important conclusions drawn from the consideration of the cell-counts are connected with cases of pleocytosis in syphilitic nervous disease, we classify our matter so as to dispose of the other, less important, cases first.

Classification of the Cases.

The serum-W.R. and the cell-count may be used as "crucial" dividing tests, marking off the cases into four groups, as follows:—

Group I.—Serum-W.R. negative, without pleocytosis.
„ II.—Serum-W.R. negative, with pleocytosis.
„ III.—Serum-W.R. positive, without pleocytosis.
„ IV.—Serum-W.R. positive, with pleocytosis.

The c.s.f.-W.R. does not disturb the distribution that we have just made. For it comes out positive practically only in cases with both (1) positive serum-W.R., and (2) pleocytosis—that is, only in the most important group, IV., which we shall consider in detail after disposing of the other groups, I. to III.

As the tables of **Group I.** possess interest in general rather than in detail, they are not printed in this article.

They concern the cases with the W.R. negative in serum and in c.s.f. and without pleocytosis.

These cases number 62, and include:—

Peripheral neuritis	4	Non-syphilitic cerebral and bulbar thrombosis	2
Subacute combined degeneration	2	Labyrinthine disease (Menière)	2
Amyotrophic lateral sclerosis	1	Neoplasm of ilium	1
Non-syphilitic progressive muscular atrophy	2	Gallstones	1
Poliomyelitis (old)	1	Gallstones c. congenitally abnormal pupillary reaction	1
Spastic paraplegia	2	Non-syphilitic myocardial failure	1
Cerebro-spinal tract lesion	1	Epileptiform seizures	1
Friedreich's ataxy	1	Paranoia	2
Neoplasm of cord	1	Simple amentia	1
Neoplasm of the vertebræ	1		
Hæmatomyelia	1		
Cerebral neoplasm	5		

In these 62 cases the cell-count rarely reached 4 per c.mm. In one case of neoplasm of the left crus cerebri, the cerebro-spinal fluid showed 10 cells in $7\frac{1}{2}$ c.mm., while the ventricular fluid taken at operation showed no cells in the same volume.

The cases in **Group II.** (serum-W.R. negative, and c.s.f.-W.R. negative, but with pleocytosis), number 14. Taken along with the cases of syphilitic meningitis (of Group IV., to be dealt with presently) they illustrate the recognised fact that the cell-count indicates the activity of the meningeal reaction rather than the nature of the infective virus. One non-fatal case of meningitis showed 1500 cells (80 per cent. polymorphonuclear, and 1 per cent. plasma cells, the rest being lymphocytes). Other cases of non-syphilitic meningitis had cell-counts equalled by those of syphilitic meningitis.

Group III., p. 354, consists of some thirty-five cases with serum-W.R. positive, but, at the time of observation, c.s.f.-W.R. negative.

Some of these cases have become c.s.f.-W.R. negative through treatment.

Others again, *e.g.*, M. C., case 19; W. C., case 21; G. C., case 22; E. H., case 24; C. K., case 25, are of special interest, as illustrating a fact pointed out by the authors[1] already mentioned, namely, that in the cerebral type of cerebro-spinal syphilis, the c.s.f.-W.R. either is only weakly positive or is negative.

Group IV. consists of all the cases with the serum-W.R. positive and with pleocytosis. Practically speaking, all these cases, and only these cases, have, or had, or would have had, the c.s.f.-W.R. positive. If at first observation of these cases the c.s.f.-W.R. is negative, it is so because treatment either has made it negative or has prevented it from becoming positive.

By their relation to treatment the cases are divided into three sub-groups:—

First, untreated cases forming sub-group IV*a*.

Second, cases much improved under treatment, sub-group IV*b*.

Third, cases less improved under treatment, sub-group IV*c*.

Sub-group IV*a*., p. 355, is made up of untreated cases, diagnosed with certainty through the indisputable aid that recent laboratory methods have brought to clinical observation. In many of the patients at the time of first observation it is impossible to say whether the condition is to be called "cerebro-spinal syphilis," and a hopeful prognosis given, or whether it belongs, or may presently, especially if no treatment now be applied, belong to the clinical group "parasyphilis," with its relatively hopeless prognosis.

But here come in alike the value of treatment and the value of modern methods in controlling treatment. The tables, of consecutive cases, merely re-grouped in this article, indicate, in sub-group IV*b*. and sub-group IV*c*., p. 359, just how much the W.R. and the pleocytosis can be modified by intravenous injections of neo-salvarsan. In subsequent articles the authors mentioned will show that in the cases of sub-group IV*b*. ("cerebro-spinal syphilis"), the fall in the W.R. and in the cell-count is followed by actual improvement in function, which improvement in some cases proceeds to the recovery of good bodily health with some mental improvement, and in other cases amounts to practically complete recovery, *e.g.*, F. J., case 92.

Moreover, they will show that, even in the cases of sub-group

[1] M'Intosh, Fildes, Head, and Fearnsides, *Brain*, xxxvi., July (1913), p. 17.

IV*c*. ("parasyphilitic" cases), considerable clinical improvement takes place in some cases, corresponding, no doubt, to some arrest of the inflammatory processes, though not to resolution of any secondary degenerations.

Parallelisms and Divergences of the W.R. Curve and the Cell-Count Curve.

Examination of the figures in Group IV. will show interesting parallelisms and divergences of, as it were, the W.R. curve and the cell-count curve.

1. The c.s.f.-W.R. and the cell-count may fall together, either (*a*) under treatment, or (*b*) without treatment.

(*a*) In seven cases the fall in the c.s.f.-W.R. and in the cell-count took place under treatment, and was followed by clinical improvement:—A. A., case 81; probably C. B., case 82, and D. B., case 83, although the specimen for the high cell-count in these two cases was not secured; J. G., case 89; F. J., case 92; E. W., case 105; W. Hr., case 122.

(*b*) In two other cases the fall occurred without treatment, but the fall was slight, and merely no fresh manifestations of the disease appeared:—W. H., case 120; D. S., case 130.

Similarly, a cell-count already near normal may, under treatment, fall still further along with some fall in the W.R.:—F. P., case 99. In this patient there has been continued fall in the W.R. for the nine months since the cell-count reached 1 per c.mm.

2. The c.s.f.-W.R. and the cell-count may rise together some time after treatment, probably through a recrudescence of the disease after insufficient injection of the drugs:—W. G., case 90; G. P., case 98; A. B., case 106; A. G., case 117; Wm. G., case 118.

These are our only instances of pleocytosis increasing after treatment with neo-salvarsan had been applied. They are probably all instances of relapse, and not of a pleocytotic rise provoked by salvarsan.

In A. B., case 106, the c.s.f.-W.R. and the cell-count did improve after treatment, and then relapsed. G. P., case 98, showed recrudescence to W.R. 44442/44443 six months after treatment, then, after further vigorous treatment, the W.R. fell to 0/42000.

3. In two classes of cases the very coincidence of negative

W.R. with negative cell-count is of interest, (*a*) cerebral syphilis and gumma cerebri (Group III., p. 354), probably examples of purely cerebral lesions, whether meningeal or not, "when the cerebro-spinal fluid usually yields a negative reaction,"[1] (*b*) E. I., case 124, a naturally arrested case of tabes dorsalis.

4. The cell-count may begin to fall sooner than the c.s.f.-W.R.:—S. O., case 62; C. C., case 112; V. W., case 138. The cases mentioned in (6) are more advanced instances of this.

5. The cell-count may remain high after the W.R. has fallen to 0:—F. R., case 100; G. W., case 136. "In both these patients the strength of the W.R. at the time of first observation was small, and the affection was in the region of the exit of the third cranial nerve. In case 100, the lesion was apparently basal; in case 136 it was a thrombotic lesion giving rise to Weber's syndrome."

6. The c.s.f.-W.R. usually falls more slowly than the cell-count, and may even for some time after the cell-count has reached normal (A. C., case 84; R. G., case 91; F. P., case 99; M. S., case 102; F. G., case 119; T. M., case 127; F. S., case 134), still remain of appreciable strength, indicating that, even so far as concerns the c.s.f. and the tissues represented by the c.s.f., there is still an indication of unresolved mischief. Moreover, the serum-W.R. usually falls still more slowly, thus prolonging the warning:—F. P., case 99; M. S., case 102; E. W., case 105, and *e.g.*, the other cases quoted under (1), p. 346.

We may here remind ourselves that the c.s.f., and the tissues represented by it, constitute by no means the whole patient, and that, valuable as are these three signs (serum-W.R., c.s.f.-W.R., and cell-count), they have their limitations.

But they have also their great significance, namely, that in the case of disappearance of even only two of them, c.s.f.-W.R. and pleocytosis, the neo-salvarsan injected into the blood-stream has reached the diseased meninges, and has profoundly affected the lesion to the patient's benefit.

It might suggest itself that the W.R. and syphilitic pleocytosis are caused by the presence of the same substance in the c.s.f., inasmuch as these two signs practically always occur together in the c.s.f. in nervous syphilis—as was pointed out in the remark on Group IV., p. 344. However, the tables of Group IV. indicate pretty consistently that in nervous syphilis pleocytosis (1) often,

[1] *Brain*, xxxvi., July (1913), pp. 20, 28, note 5.

or perhaps always, appears before the W.R. in the c.s.f., and (2) often, or generally, disappears before the W.R. has disappeared.

Now the earlier appearance of pleocytosis might suggest that a small amount of the just-appearing Wassermann substance suffices to stimulate pleocytosis. But the disappearance of pleocytosis while the W.R. is still strong indicates that the substance exciting pleocytosis is distinct from the Wassermann substance.

The fact that these two tests are, as it were, independent witnesses, renders their concurrent testimony of much greater value.

7. Pleocytosis may appear and even rise high before the W.R. appears in the c.s.f.:—A. M., case 59; W. G., case 90; E. W., case 104.

This very important sign is, especially in these days of neo-salvarsan, at once acted on; and prompt treatment prevents the appearance of the confirmatory W.R. in the c.s.f.

The following note on W. G., courteously supplied for this article, will be read with interest.

"Clinically W. G. showed on his first admission to hospital merely subjective manifestations—malaise and pains in various regions—together with pyrexial attacks."

The brisk mercurial treatment applied resulted in apparent recovery, followed, however, two years afterwards by a recurrence with more severe pyrexial attacks.

"On his second admission, however, evidence of irritation of certain spinal nerve roots was forthcoming. This irritation disappeared within 36 hours after the first injection of neo-salvarsan. The presence of the root irritation gave a reasonable explanation for the cytological findings."

Of further interest is the case of C. G., case 44. This patient, with the secondary rash at its height, had W.R. 44444/44000 and a pleocytosis so high, 153, as to suggest that it might have appeared before the W.R. in the c.s.f. The methods of investigation used by Dr Head and Dr Fearnsides demonstrated irritation of some spinal nerve roots within four months of infection. J. W., case 80, is also a case of nervous disease in secondary syphilis.

Instances (4), p. 347, and (7), p. 348, of divergences of the cell-count "curve" from the W.R. "curve," show that, both in the diagnosis of early cerebro-spinal meningitic disease, and in indicating progress under treatment, the cell-count is, on the whole,

a more sensitive but not less reliable indicator than the W.R., and is certainly a diagnostic means that ought not to be neglected, especially when, in any case, the c.s.f. has been procured for the Wassermann test. Indeed, the W.R. and the cell-count are, of course, not rival diagnostic tests, but are mutually supplementing, mutually correcting, mutually supporting—just as the combined arguments of such laboratory findings, on the one hand, and the combined arguments of clinical findings on the other hand, are not rivals, but are co-operating combined arguments to show up clearly the condition from time to time of the patient.

The Meiostagmin Test and Phase I. Test.

Some work was done on two other tests.

The meiostagmin test, performed by means of the author's constant-pressure dropping apparatus,[1] was tried on a number of the earlier specimens after the Wassermann test. But the greatest fall in surface tension took place by no means always in the W.R.-positive c.s.fs.

Phase I. test was done on most of the specimens. Usually the degree of opalescence, measured merely by the eye, was roughly proportional to the number of cells present, or to the W.R., whether meningeal affection was absent or was caused by any form of syphilis or by tubercle. But in other cases the opalescence was far from proportional either to the W.R. or to the cell-count. For instance, sometimes a case with W.R. negative in serum and in c.s.f. and with one cell per c.mm., showed more of opalescence than a case with W.R. positive in serum and in c.s.f. and with thirty-five cells. These apparent anomalies indicate the need for considerable experience in using this test and for considerable judiciousness in interpreting its findings.

One source of possible error is serum globulin remaining in the c.s.f. after the corresponding few red cells have broken up and are represented by only a faint straw colour, easily missed by artificial light.

In S. O., case 62, tabes dorsalis, the test gave a nearly opaque white, although two years before, with a very similar Wassermann result, Phase I. test had given "only a slight opalescence."

[1] Donald, *Proc. Royal Society*, 1913, Vol. lxxxvi., pp. 198-202.

Notes on Kinds of Cells Found.

The cells of c.s.f. have been described by Cornell,[1] by Szécsi,[2] by Plaut, Rehm, and Schottmüller,[3] and by others.

Of the various cells demonstrated in this investigation, some kinds call for special mention.

Plasma cells were found, forming 0·2 to 3 per cent. of the cell-count in syphilis meningo-vascularis, syphilitic encephalitis, tabes dorsalis, general paralysis, juvenile general paralysis, also in the meningitis of secondary syphilis, and in the following non-syphilitic conditions:—Disseminated sclerosis, hydrocephalus, cerebral hæmorrhage, and in two non-fatal cases of meningitis of which the causative organism did not grow in culture.

In the case of juvenile general paralysis (A. B., case 106), plasma cells were found in nearly the same percentage in the three specimens taken during the nine months after injection of 1·8 g. of 914.

One case of the meningitis of secondary syphilis (C. G., case 44) had 3 per cent. plasma cells, with 75 per cent. of polymorphonuclears in a total cell-count of 154.

Polymorphonuclear leucocytes were found in the meningitis of secondary syphilis, as just mentioned, and in smaller proportions in some other cases as shown in the tables.

Where not otherwise specified, the total cell-count or the balance consisted of lymphocytes.

Swollen (degenerated) cells, whether present in the fluid when drawn, or developed later from sound cells, were included in the cell-counts as given.

The total cell-count is, as shown in the tables and in the notes on them, of special value.

The fairly large number of cell-counts considered above shows a remarkable concordance. For the periods, up to eighteen months, the successive counts, as many as five, of each case, are consistent with one another, and are, in nearly all the cases, roughly "proportional" to the simultaneous Wassermann figures. The few

[1] Cornell, *Amer. Journ. of Insanity*, 1907-8, Vol. lxiv., p. 73.

[2] Szécsi, *Monatsschr. f. Psychiat. u. Neurol.*, Bd. xxix., S. 76-82; *Zeitschr. f. d. ges. Neurol. u. Psychiat. Or.*, 1911, Bd. vi., S. 537; *Fol. Hæmat.*, 1910-11, Bd. x., *Archiv.*, S. 534.

[3] Plaut, Rehm, und Schottmüller, *Leitfaden zur Untersuchung der Zerebrospinalflüssigkeit*, Jena, 1913.

divergences of the cell-count from this rough "proportionality" are highly significant, and are consistent with the patient's clinical condition.

Case 99, F. P. -	44443/44443 5	44441/44400 3	44440/44200 1	4444–/44400 1	44440/30000 1
Case 98, G. P. -	0/44100 85	44442/44443 90	44200/44400 3	...	0/42000 4
Case 124, E. I. -	20000/0 1	22000/0 about 1	20000/0 1	...	...
Case 107, A. B. -	44444/44420 46 2 per cent. plasma cells 5 per cent. polymorph.	44440/44000 21 1 per cent. plasma cells 3 per cent. polymorph.	44440/44440 38 1 per cent. plasma cells 1 per cent. polymorph.	...	...
Case 89, J. G. -	44444/44443 ...	44443/44300 16	44100/0 4	0/0 2	...
Case 92, F. J. -	44430/44440 63	44444/44000 19	44440/0 2	...	...
Case 120, W. H.	43200/44300 12	43100/42000 7	...	...	...
Case 122, W. Hr.	44444/44400 44	44430/40000 3½	...	...	...
Case 125, F. K. -	44442/44440 44	44444/44300 6	...	...	...

The many other cell-counts obtained in this research are all similarly consistent with the just-quoted counts.

In face of this concordance in the cell-counts, we may assume that in the subarachnoid space, or at any rate in the part of it reached by lumbar punction, the cells are to a considerable extent maintained in suspension—by alterations in body-posture and in the amounts of blood within the bony spinal canal.[1]

Explanation of Abbreviations and Notation.

The case numbers as assigned are merely for convenience in referring to the cases in this paper.

[1] O. Fischer found in P.M. subjects different cell-counts at different levels of tapping (*Monatsschrift für Psychiatrie und Neurologie*, June, 1910). Summarised in *Folia Hæmatologica*.

The few necessary abbreviations will be readily understood—"606" for "salvarsan," "914" for "neosalvarsan," "914-serum" for "neo-salvarsanised serum," "S." for "syphilis," "Sc." for 'syphilitic," "c.s.f." for "cerebro-spinal fluid."[1]

The notation of the W.R. results is explained in the words of the authors above referred to.[2]

"Throughout this investigation we record the results of the W.R. in this form. The test is quantitative, and falling doses of serum and cerebro-spinal fluid are used. Formerly we followed the usual method of recording the reaction and represented complete inhibition by ++++ and incomplete inhibition by +++, ++, or +. To economise space these would now be written 4, 3, 2, or 1. The figures 4, 4, 4, 4, 4 imply that the reaction was complete in each of the five dilutions, whilst 4, 4, 4, 0, 0 shows that the reaction was complete in the first three, but negative in the last two dilutions. Such results as 2, 0, 0, 0, 0 or 1, 0, 0, 0, 0 have no diagnostic value. The figures above the line always refer to the serum, those below the line to the cerebro-spinal fluid."[2]

In this article, for further saving of space in the extensive tables, the horizontal line is represented by an oblique stroke, the figures to the left of the stroke referring, of course, to the serum. Similarly, the negative result of the tests—here always quantitative—is represented by a single 0 instead of 00000.

[1] Apology is hardly needed for printing "c.s.f.-W.R." for "Wassermann reaction in the cerebro-spinal fluid," especially just before the terse notation of the quantitative reaction. The German "Cerebrospinalflüssigkeit" and the French expression are no shorter than the English name. Serious writers express their intolerance of the long term by often printing "fluid" in English or "Liquor" in German, and by probably never writing the long clear expression.

[2] M'Intosh, Fildes, Head, and Fearnsides, *Brain*, Part I., 1913, Vol. xxxvi., p. 5.

Group II.

Serum-W.R. negative with pleocytosis (c.s.f.-W.R. negative).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
1.	W. B.	...	Tuberculous meningitis. (P.M.)	...	Dec. 13, 1913.	84; 4 per cent. polymorph.
2.	I. C.	42	Basal tumour.	...	Mar. 25, 1914, 0/0.	8.
3.	I. Dp.	5	Hydrocephalus.	...	Dec. 3, 1913, 0/0.	200; 20 per cent. polymorph., 0·3 per cent. plasma cells. Many r.b.c. allowed for.
4.	L. E.	...	Disseminated sclerosis.	...	Oct. 29, 1913, 0/0.	53; 1 per cent. plasma cells (atypical), 2 per cent. polymorph.
5.	Em. H.	...	Cerebral tumour. (Proved by P.M.)	...	Dec. 20, 1913.	15.
6.	J. H.	9	Tuberculous meningitis. (P.M.)	...	Apr. 9, 1913.	400; 2·2 per cent. polymorph., 2·5 per cent. swollen.
7.	D. J.	...	Cerebral tumour.	...	May 6, 1914, 0/0.	8.
8.	R. K.	49	Cerebral hæmorrhage and fits.	...	Nov. 12, 1913, 0/0.	200; 1 per cent. plasma cells, 0·3 per cent. mast cells, but blood present.
9.	H. L.	...	Tuberculous meningitis. (P.M.)	...	May 22, 1914.	100; 40 per cent. swollen, 0·1 per cent. plasma cells (one day old).
10.	N. L.	...	Acute anterior poliomyelitis.	...	Nov. 4, 1913.	52; 70 per cent. swollen.
11.	V. P.	4	Meningitis. Cause?	...	Apr. 3, 1913, —/—	280; 3 per cent. polymorph., 4 per cent. swollen.
12.	"Y.R."	...	Cerebral tumour.	...	May 20, 1914, 0/0.	18.
13.	"T.V."	...	Mngtic. symptoms.	...	Oct. 22, 1913.	7.
14.	Wm.Y.	3	Acute mngtis., non-fatal.	Organism failed to grow in culture.	...	1500; 80 per cent. polymorph., 1 per cent. plasma cells.

Group III.

Serum-W.R. positive without pleocytosis (c.s.f.-W.R. negative).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
15.	C. B.	53	Depression in a syphilitic. S.I. at 23.	None.	Dec. 3, 1913, 4——/— Dec. 17, 1913, 44444/0.	 1.
16.	M. B.	36	Nephritis in a syphilitic.	4 years' Hg. and Kl.	June 4, 1913, 4——/0.	½.
17.	E. B.	42	Myasthenia grav. in a syphilitic.	None.	April 23, 1913, 44444/0.	1.
18.	P. B.	26	Transverse myelitis (stationary).	Has had much Hg. and also salvarsan.	May 14, 1913, 0/0.	4.
19.	M. C.	57	Cerebro-spinal S. (Cerebral type.)	...	April 1, 1914, 44300/0.	1.
20.	S. C.	37	Jacksonian seizures in a syphilitic. Gumma of post-central region (operation 1911).	Bromides, Iodides and Hg. 3 years.	April 29, 1914, 43000/0.	3.
21.	W. C.	38	Old cerebral S. hemiplegia.	Inunctions of Hg. and much Kl. in 1911.	April 22, 1914, 44400/0.	2.
22.	G. C.	...	Old cerebral thrombosis. Left hemiplegia, Jan. 1913.	3 "doses" 606 in Canada.	Aug. 20, 1913, 44441/0. Dec. 17, 1913, 44441/0.	1. 3.
23.	W. G.	53	Progressive muscular atrophy in a syphilitic.	Hg.	Jan. 29, 1914, 4——/0. Mar. 4, 1914, 44444/0.	... 1.
24.	E. H.	39	Gumma cerebri. Increased intracranial pressure. Secondary optic atrophy.	June 28, 1913, 0·6 (914). July 10, 1913, 0·9 (914). July 17, 1913, 0·9 (914).	June 25, 1913, 41000/0 July 25, 1913, 40000/—. Nov. 5, 1913, 42100/—. Nov. 12, 1913, 30000/0.	3. ... ... 2/7.
25.	C. K.	58	Cerebral S. Aortic disease.	Hg. and Kl. in 1911.	July 30, 1913, 44444/10000.	2.
26.	B. L.	43	Psychasthenia in a syphilitic.	Hg. 4 months. April 1913, 0·9 (914) 3 doses.	Oct. 23, 1912, 44444/0. April 16, 1913, 44444/0. July 2, 1913, 44444/—. April 1, 1914, 44440/0.	... 1. ... 2/7.
27.	A. M.	41	Cerebral S.	Hg. and Kl. 2 years.	Jan. 1, 1913, 44443/0.	½.

GROUP III. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
28.	E. P.	27	Multiple gummata. Congenital S.	None recently.	May 21, 1913, 44444/0.	1.
29.	M. R.	18	Interstitial keratitis. Congenital S. TBs. hip.	None.	June 25, 1913, 0/0.	1.
30.	A. S.	35	Epilepsy in a syphilitic.	Bromides only.	Jan. 14, 1914, 4——/—.	...
					Mar. 18, 1914, 44420/0.	2.
31.	L. Sp.	31	Sc. thrombosis of cord.	Kl. Oct. 3, 1913, 0·9 (914).	Oct. 8, 1913, 44442/0.	2.
32.	E. W.	31	Vestibular disease in a syphilitic.	Injections of Hg. and Kl.	Jan. 8, 1913, 42100/0.	2.
33.	F. W.	42	Epilepsy in a syphilitic.	...	June 11, 1913, 44430/0.	3.

GROUP IV.

W.R. pos. pos., with pleocytosis.

(Only Group IV. has W.R. positive in c.s.f.)

Group IV. consists of:—

Group IV*a*.—Untreated nervous syphilis.
„ IV*b*.—Nervous syphilis much improved under treatment.
„ IV*c*.—Nervous syphilis less improved under treatment.

GROUP IV*a*.—UNTREATED NERVOUS SYPHILIS.

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
34.	J. A.	60	Tabes optica. Primary optic atrophy. No other manifestation. (P.M.)	...	May 7, 1913, 44300/44300.	33.
35.	F. B.	35	Probably spinal thrombosis.	...	Jan. 21, 1914, —/44400.	80; 41 per cent. polymorph.
					Feb. 4, 1914, 4——/—.	...
					Feb. 11, 1914, 44430/—.	...
36.	S. B.	32	Acute Sc. enceph. P.M. verification.	...	May 27, 1913, 44444/44444.	35.

GROUP IV*a*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
37.	C. B.	46	Tabes dorsalis. Cerebro-spinal syphilis, root lesion, primary atrophy, A. R. pupils.	...	June 10, 1914, 44310/44000.	9; 40 per cent. swollen (3 days old).
38.	J. C.	51	Tabes dorsalis.	...	Mar. 29, 1912, 44430/31000.	36.
39.	A. C.	40	Tabes dorsalis with some amyotrophy of upper limb.	...	Aug. 20, 1912, 41000/44441.	...
					Feb. 25, 1914, 40000/44440.	100; 0·5 per cent. plasma cells.
40.	R. C.	36	Amyotrophy with cerebral affection and spasticity of lower limbs.	...	Dec. 4, 1912, 44442/44100.	39.
41.	W. C.	51	Sc. mngtis, root lesions.	None recently.	Oct. 29, 1913, 4——/—.	...
					Dec. 3, 1913, 44440/44440.	30.
43.	S. G.	41	Cerebro-spinal syphilis.	...	Mar. 4, 1914, 44410/44400.	35.
44.	C. G.	...	S. II. *c.*, root lesions.	...	June 10, 1914, 44444/44000.	154; 75 per cent. polymorph., 3 per cent. plasma cells.
45.	H. G.	39	Sc. spinal meningitis with A. R. pupils.	...	Feb. 11, 1914, 44440/44000.	74; 1 per cent. plasma cells. Red cells present.
46.	T. G.	32	Tabes dorsalis. Perforating ulcer of foot.	...	Dec. 4, 1912, 43200/44400.	50.
					Jan. 29, 1913. 44310/—.	...
47.	W. H.	39	Tabes dorsalis.	...	Feb. 25, 1914, 44440/44400.	18.
48.	H. H.	37	Tabes dorsalis, *c.* gastric crises.	...	Apr. 1, 1914, 44440/44440.	10.
49.	A. H.	46	Cerebral S. Manifestations chiefly mental.	...	Feb. 18, 1914, 2——/—.	...
					Feb. 25, 1914. —/44000.	25.
50.	K. H.	...	Acute meningo myelitis.	...	Nov. 5, 1913.	426; 5 per cent. polymorph., 3 per cent. plasma cells; 3 per cent. endothelial cells.

GROUP IV*a*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
51.	W. J.	47	Spastic paraplegia.	...	April 22, 1914, 444—/44200.	35; 5 per cent. plasma cells.
52.	G. J.	35	Sc. hemiplegia with amyotrophy of right upper limb.	...	Nov. 12, 1913, 4——/—.	...
					Nov. 19, 1913, 44441/44300.	1.
53.	S. K.	30	S. meningo vascularis, mental deterioration.	...	Mar. 25, 1914, 44430/41000.	64; 1 per cent. polymorph., 1 per cent. plasma cells.
54.	H. K.	21	Gummatous mngtis. Sc. lesions of nucleus of 9th, 10th and 11th cranial nerves. S.I. 12 months ago.	...	Mar. 5, 1913, 44440/0.	23; (many red cells present. Blood leucocyte count not secured.)
55.	L.	...	Dementia paralytica.	...	Feb. 3, 1914,	60; Red cells allowed for.
56.	R. M.	29	Sc. enceph.	...	Feb. 25, 1914, 44444/44440.	65.
58.	E. M.	49	Cerebro-spinal meningitis.	...	July 9, 1913, 444—/43000.	6; specimen 3 days old.
59.	A. M.	42	Sc. encephalitis with leukoplakia.	...	Mar. 4, 1914, 4——/—.	...
					Mar. 11, 1914, —/0.	250; 30 per cent. polymorph., 0·3 per cent. plasma.
					Mar. 18, 1914, 44442/—.	...
60.	J. M.	42	Tabes dorsalis.	...	Feb. 28, 1912, 4——/—.	...
					May 22, 1912, 44444/44444.	11.
61.	E. M.	47	Tabes dorsalis.	...	Mar. 25, 1914, —/44440.	12.
					April 1, 1914, 44444/—.	...
62.	S. O.	36	Tabes dorsalis.	...	May 15, 1912, 10000/—.	
					May 22, 1912, 10000/44441.	15; Phase I., slight opalescence.
					Apr. 1, 1914, 20000/44444.	3; c.s.f. markedly alkaline. Phase I., nearly opaque white.

GROUP IV*a*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
63.	H. O.	30	Cerebro-spinal S. affection of many cranial nerves and spinal roots.	...	Feb. 18, 1914, 44444/44440. June 19, 1914, 44440/0.	55; 0·3 per cent. plasma. ...
64.	A. O.	55	Cerebro-spinal S. affecting many cranial nerves and several spinal nerve roots.	...	June 25, 1913, 44000/44400.	90; 1 per cent. mast cells, 0·5 per cent. plasma cells.
65.	C. P.	35	Sc. meningitis.	...	Dec. 17, 1913, 0/0.	15.
66.	G. Pb.	51	Pseudo-tabes syphilitica.	...	Oct. 8, 1913, 44444/44310.	14.
67.	T. P.	41	Cerebro-spinal S. A.R. pupils, root lesions, spastic paraplegia.	...	June 10, 1914, 4——/44000.	53; 1 per cent. polymorph.
68.	G. R.	50	Tabes dorsalis. Primary optic atrophy.	...	Nov. 19, 1913, 44444/44000.	6.
69.	T. S.	43	Tabes dorsalis.	...	Apr. 17, 1913, 44440/44100.	36.
70.	E. S.	30	"Gastric crises."	...	Apr. 30, 1913, 0/44100. Nov. 29, 1913, 0/0.	12. ...
71.	"T.S."	...	Meningo-myelitis.	...	July 16, 1913, 4——/4——.	200; nearly all expanded. Sample some days old.
72.	F. S., of B.	42	Dementia paralytica.	...	May 13, 1914, 44444/44440.	31.
73.	D. T.	43	Spastic paraplegia. *c.* A.R. pupils.	...	Apr. 23, 1914, 44444/44431.	12.
74.	W. T.	39	Cerebro-spinal S. (S. 20 years ago.) Gumma of testicle.	...	Dec. 15, 1913, 44444/44444.	36.
75.	C. W.	41	Tabes dorsalis. Ophthalmoplegia externa.	...	Apr. 23, 1913, 4——/—. Mar. 4, 1914, 44400/44440.	... 104; 0·2 per cent. plasma cells.
76.	S. W.	52	Basal mngtis. affecting many cranial nerves.	...	May 12, 1914, 44440/44400.	40.
77.	G.R.W.	60	Sc. bulbar thrombosis. (P.M.)	...	Mar. 18, 1914, 4——/—. Mar. 25, 1914, —/40000. Apr. 1, 1914, 44444/—.	... 27. ...

GROUP IV*a*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
78.	E. W.	23	Acute encephalitis (mental manifestations).	Hg. 4 years ago.	Feb. 11, 1914, 4——/—. Feb. 18, 1914, —/44444.	... 13.
79.	E. W.	30	Depression.	...	May 13, 1914, 44444/44444.	29; 1 per cent. mast cells.
80.	J. W.	...	Acute S. II. *c.* affection of many spinal and cranial nerves.	...	Apr. 15, 1914, 4——/44400.	43; 6 days old.

GROUP IV*b*.

Nervous Syphilis Much Improved under Treatment.

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
81.	A. A.	49	Basal mngtis. affection of many cranial nerves and several spinal nerve roots.	May 6, 1913, 0·9 (914). May 9, 1913, 0·9 (914). June 26, 1913, 0·9 (914).	April 30, 1913, 44444/44432. Oct. 29, 1913, 44441/0.	33. 4.
82.	C. B.	41	Brown-Séquard paralysis.	1911, Hg., 36 inunctions. July 22, 1912, 0·6 (606). July 27, 1912, 0·9 (914). June 28, 1913, 0·9 (914).	June 19, 1912, 44410/41000. July 2, 1913, 44410/0. Oct. 15, 1913, 44410/—. Dec. 2, 1913, 44000/0.	... 1. ... 2.
83.	D. B.	42	Sc. transv. myelitis (stationary).	Aug. 1912, 0·9 (914). Aug. 1912, 0·9 (914). May 1913, 0·9 (914). May 1913, 0·9 (914).	Aug. 2, 1912, 44443/44432. April 30, 1913, 44443/—. May 21, 1913, 44430/0. Feb. 18, 1914, 44440/0.	... ... 4. 2.
84.	A. C.	41	Gastric crises.	Aug. 1913, 0·9 (914). Aug. 1913, 0·9 (914). Aug. 1913, 0·9 (914). Feb. 1914, 0·9 (914).	Aug. 6, 1913, 444—/44440. Feb. 18, 1914, 44440/44440.	40; 23 per cent. polymorph. 4; red cells allowed for.

GROUP IV*b*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
86.	G. D.	40	Sc. hemiplegia in 1906.	Hg. 2 years. Feb. 11, 1912, 0·6 (606). Feb. 17, 1912, 0·6 (606).	Feb. 7, 1912, 32000/0.	2.
					June 15, 1912, 21000/—.	...
					May 21, 1913, 0/—.	...
					July 2, 1913, 0/—.	...
					Nov. 12, 1913, 0/0.	1.
					May 27, 1914, 0/0.	1.
87.	W. F.	45	Pseudo-tabes syphilitica, with amyotrophy of legs.	Iodides.	Mar. 5, 1913, 4——/—.	...
					Mar. 4, 1914, 44420/44000.	2.
88.	G. F.	57	Sc. basal mngtis. affection of several cranial nerves.	Hg. July 5, 1913, 0·9 (914).	July 9, 1913, 4——/—.	...
					Mar. 4, 1914, 44444/44000.	1.
89.	J. G.	27	Acute cerebro-spinal syphilis. S.I. end of 1911.	Hg. 6 months. Oct. 14, 1912, 0·9 (914). Oct. 21, 1912, 0·9 (914). Nov. 4, 1912, 0·9 (914). Dec. 11, 1912, 0·9 (914). Mar. 6, 1913, 0·9 (914). April 23, 1913, 0·9 (914).	Oct. 8, 1912, 44444/44443.	...
					Oct. 13, 1912, 44444/44410.	...
					Dec. 10, 1912, 44443/44300.	16.
					Mar. 5, 1913, 44100/0.	4.
					April 23, 1913, 10000/—.	...
					Oct. 29, 1913, 20000/—.	...
					April 22, 1914, 0/0.	2.
90.	W. G.	...	Sc. mngtis. Nerve root irritation.	12 inunctions Hg. 1908. Hg. and Kl. 6 weeks in 1911. Mar. 4, 1912, 0·9 (914). Mar. 7, 1912, 0·9 (914). Mar. 10, 1912, 0·9 (914).	April 3, 1912, 44444/0.	112.
					Mar. 4, 1914, 44444/0.	117; 3 per cent. polymorph., 10 per cent. swollen.
91.	R. G.	52	Diffuse gummatous mngtis. S. 10 years ago.	May 16, 1913, 0·9 (914). May 31, 1913, 0·9 (914). July 14, 1913, 0·9 (914). July 31, 1913, 0·9 (914).	May 21, 1913, 44444/44444.	23; 1 per cent. microlymphocytes.
					July 23, 1913, 44442/—.	...
					Aug. 6, 1913, —/44430.	1.

GROUP IV*b*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
92.	F. J.	35	Sc. "pseudoparesis." S.I. at 29.	Iodides only, 1912.	Mar. 13, 1913, 44330/44440.	63.
				April 17, 1913, 0·9 (914).	April 16, 1913, 44444/44000.	19.
				April 22, 1913, 0·9 (914).	July 9, 1913, 4——/—.	...
				April 26, 1913, 0·9 (914).	Nov. 5, 1913, 44440/0.	2.
93.	D.G.K.	35	Sc. myelitis. Local Sc. meningitis, Th. VIII.	July 10, 1912, 0·6 (606).	July 10, 1912, 44300/44410.	...
				July 17, 1912, 0·6 (606).	May 15, 1913, 32100/0.	10.
				Jan. 1, 1913, 0·9 (914).		...
94.	A. K.	33	Diffuse meningitis and gumma of scalp.	Oct. 21, 1912, 0·9 (914).	Oct. 16, 1912, 0/4——.	...
				Oct. 31, 1912, 0·9 (914).	Oct. 30, 1912, 20000/—.	...
				Jan. 17, 1913, 0·9 (914).	Jan. 22, 1913, 43200/0.	...
				April 24, 1913, 0·9 (914).	April 23, 1913, 40000/0.	4.
				Jan. 8, 1913, 0·9 (914).		
95.	N. M.	41	Cerebro-spinal S. S.I. 3 years ago. Right hemiplegia, 2 years.	(Vigorous inunctions.)	Aug. 27, 1913, 44200/0.	3.
97.	A. P.	42	Sc. encephalitis, "pseudo-paresis" syphilitica, hyperpiesis.	July 3, 1912, 0·6 (606).	July 3, 1912, 42000/43200.	
				March 7, 1913, 0·9 (914).	May 5, 1913, 0/0.	0; the white cells are practically accounted for by the red cells.
				May 5, 1913, 0·9 (914).	June 25, 1913, 0/—.	
					Oct. 15, 1913, 0/—.	
					April 29, 1914, 0/0.	1; confirming previous count.
98.	G. P.	27	Sc. encephalitis.	Hg. 2 years. Feb. 1912, 0·6 (606).	April 3, 1912, 4——/—.	...
					Nov. 13, 1912, 40000/—.	...
				Feb. 11, 1912, 0·6 (606).	Nov. 28, 1912, 0/44100.	85.
				Nov. 27, 1912, 0·6 (914).	June 4, 1913, 44442/44443.	90.
				June 6, 1913, 0·6 (914).	July 31, 1913, 44430/—.	...
				July 12 to 26, 0·9 (914), in 4 doses.	Aug. 13, 1913, 44200/44400.	3.

GROUP IV*b*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
				Jan. 26, 1914, 0·9 (914).	Sept. 24, 1913, 44200/—.	...
					Nov. 19, 1913, 0/—.	...
					Jan. 28, 1914, 0/42000.	4.
99.	F. P.	33	Pseudo-tabes syphilitica.	Jan. 4, 1913, 0·9 (914).	Jan. 1, 1913, 44443/44443.	5.
				Jan. 14, 1913, 0·9 (914),	Mar. 2, 1913, 44441/—.	...
				Jan. 21, 1913, 0·9 (914).	Apr. 23, 1913, 44444/44400.	3.
				April 25, 1913, 0·1 (914).	May 21, 1913, 44442/—.	...
				April 29, 1913, 0·1 (914).	June 4, 1913, 44441/—.	...
				May 2, 1913, 0·1 (914).	June 16, 1913, 44441/—.	...
				May 3 to 27, 2·3 (914), in 7 doses.	July 16, 1913, 44442/—.	...
				Jan. 28, 1914, 0·9 (914).	Sept. 3, 1913, 44440/44200.	1.
				June 12, 1914, 0·9 (914).	Jan. 28, 1914, 4444-/44400.	1.
					June 10, 1914, 44440/30000.	1.
100.	F. R.	48	Gummatous mngtis. around 3rd cranial nerve.	Feb. 25, 1913, 0·9 (914).	Mar. 5, 1913, 44444/41000.	11.
				Mar. 8, 1913, 0·9 (914).	Apr. 23, 1913, 44444/0.	10.
				Apr. 23, 1913, 0·9 (914).		
101.	E. R.	39	Old Sc. muscular atrophy and lateral sclerosis. S. 19 years ago.	...	May 19, 1911. 20000/0.	...
					Feb. 26, 1913, 0/0.	...
					Oct. 29, 1913, 0/0.	1.
102.	M. S.	28	Sc. amyotrophy.	July 20, 1912, 0·9 (914).	Mar. 14, 1912, 44444/—.	...
				Aug. 1, 1912, 0·9 (914).	Apr. 22, 1912, 44444/44442.	...
				Nov. 30, 1912, 0·9 (914).	Nov. 21, 1912, —/41000.	20.
				Dec. 3, 1913, 0·9 (914).	Dec. 4, 1912, —/44300.	...
					July 9, 1913, 44410/—.	...
					Dec. 3, 1913, 44410/40000.	1.
103.	E. T.	22	Gummatous mngtis., affection of several cranial nerves.	Hg. and "606" injected abroad 18 months ago.	Jan. 22, 1913, 32000/0.	7.

GROUP IV*b*. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
104.	E. W.	33	Syphilitic hemiplegia.	"Salvarsan." Oct. 18, 1913, 0·6 (914).	Oct. 22, 1913, 44444/0.	31.
				Oct. 23, 1913, 0·9 (914).	Nov. 12, 1913, 44444/0.	20.
				Oct. 30, 1913, 0·9 (914).		
105.	E. W.	23	Sc. hemiplegia.	Mar. 7, 1913, 0·9 (914).	Mar. 5, 1913, 44444/44000.	19.
				Mar. 10, 1913, 0·9 (914).	July 2, 1913, 44442/—.	...
				Mar. 17, 1913, 0·9 (914).	Dec. 3, 1913, 44440/0.	...

GROUP IV*c*.

Nervous Syphilis Less Improved under Treatment.

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
106.	A. B.	16	Juvenile dementia paralytica.	July 19, 1913, 0·6 (914).	July 16, 1913, 44444/44420.	46; 2 per cent. plasma, 5 per cent. polymorph.
				July 25, 1913, 0·6 (914).	Oct. 29, 1913, 44440/44000.	21; 3 per cent. polymorph., 1 per cent. plasma cells.
				July 30, 1913, 0·6 (914).		
				Oct. 29, 1913, 0·6 (914).	Apr. 27, 1914, 44440/44440.	38; 1 per cent. plasma cells, 1 per cent. polymorph.
107.	A. B.	47	Epilepsy in a syphilitic (old meningitis).	Apr. 5, 1913, 0·9 (914).	Apr. 2, 1913, 44440/0.	2.
				Apr. 12, 1913, 0·9 (914).	Oct. 15, 1913, 44443/—.	...
				Apr. 19, 1913, 0·9 (914).	Dec. 17, 1913, 44442/0.	3.
				July 9, 1913, 0·9 (914).		
108.	J. B.	37	Pseudo-paresis syphilitica.	Hg. 4 months. Sept. 24, 1912, 0·9 (914).	Sept. 18, 1912, 43000/42000.	...
				Sept. 28, 1912, 0·9 (914).	June 18, 1914, 30000/44200.	8.
109.	H. B.	42	Taboparesis. S. 1894. (P.M.)	Hg. 12 months. Oct. 25, 1912, 0·9 (914).	Oct. 23, 1912, 44431/44441.	...

GROUP IVc. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
				Oct. 29, 1912, 0·9 (914).	Feb. 5, 1913, 44410/—.	...
				Feb. 1, 1913, 0·9 (914).	Sept. 3, 1913, 44432/44420.	4; specimen 3 days old.
110.	J. C.	...	Dementia paralytica progressive.	June 6, 1912, 0·6 (606).	June 5, 1912, 44421/44432.	...
				June 12, 1912, 0·6 (606).	Aug. 20, 1913, 44440/44420.	25; 1 per cent. plasma cells.
111.	E. C.	43	Taboparesis.	...	Sept. 24, 1913, 4——/—.	...
					Oct. 2, 1913, 4——/44444.	...
					May 13, 1914, 44441/44442.	24.
112.	C. C.	43	Tabes dorsalis. Leukoplakia, epithelioma of tongue. Death from secondary carcinomatosis. (No P.M.)	Nov. 3, 1912, 0·9 (914).	Oct. 8, 1912, 44200/44310.	...
				Nov. 8, 1912, 0·9 (914).	Dec. 4, 1912, 43200/—.	...
				May 4, 1913, 0·9 (914).	Mar. 19, 1913, 44200/—.	...
					May 7, 1913, 44420/44200.	30.
					Sept. 10, 1913, 44420/44200.	10.
113.	S. D.	29	Taboparesis progressive. Later 4 intrathecal injections, each 10 c.c. of "914-serum."	June 1, 1913, 0·9 (914).	June 1, 1913, 44443/44444.	22.
				June 21, 1913, 0.9 (914).	Oct. 8, 1913, 44444/—.	...
				June 27, 1913, 0·9 (914).	Jan. 14, 1914, 44444/44444.	28; 30 per cent. polymorph.
				Sept. 29 to Oct. 10, 1913. 4 times 0·3 (914) in 30 c.c. Jan. 1914, 0·9 (914).	July 8, 1914, 44444/44444.	18; blood accounted for 9 cells.
119.	F. G.	24	"Parasyphilitic" epilepsy, congenital S.	June 6, 1913, 0·9 (914).	June 4, 1913, 44—/44440.	40.
				June 15, 1913, 0·9 (914).	June 11, 1913, 44200/—.	...
				June 18, 1913, 0·9 (914).	Dec. 3, 1913, 44100/44000.	1.
122.	W.Hr.	36	Muscular atrophy.	April 5, 1913, 0·9 (914).	Feb. 26, 1913, 4——/—.	...
				April 12, 1913, 0·9 (914).	April 3, 1913, 44444/44400.	44.
				April 19, 1913, 0·9 (914).	Sept. 24, 1913, 44443/43000.	...
				Sept. 23, 1913, 0·9 (914).	May 13, 1914, 44430/40000.	3½.
118.	W. G.	35	Sc. hemiplegia.	May 20, 1913, 0·9 (914).		...

GROUP IVc. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
				May 30, 1913, 0.9 (914).	Aug. 20, 1913, 44444/44444.	50.
				Sept. 14, 1913, 0·9 (914).	Nov. 5, 1913, 44441/—.	...
				Jan. 14, 1914, 0·9 (914).	Jan. 14, 1914, 44440/44444.	163.
119.	F. G.	24	Parasyphilitic epilepsy, congenital S.	June 6, 1913, 0·9 (914).	June 4, 1913, 44—/44440.	40.
				June 13, 1913, 0·9 (914).	June 11, 1913, 44200/—.	...
				June 18, 1913, 0·9 (914).	Dec. 3. 1913, 44100/44000.	1.
120.	W. H.	54	Erb's Sc. spinal paralysis (stationary).	No treatment in 1912.	Feb. 28, 1912, 43200/44300.	12.
					May 7, 1913, 43200/—.	...
					May 21, 1913, 43100/43000.	7.
121.	O. H.	...	Dementia paralysis.	Just finished 20 injections of Hg.	Nov. 28, 1912, 20000/40000.	7.
					April 9, 1913, 4——/—.	...
					Dec. 17, 1913, 43100/30000.	1.
122.	W. Hr.	36	Parasyphilitic musc. atrophy.	April 5, 1913, 0·9 (914).	Feb. 26, 1913, 4——/—.	...
				April 12, 1913, 0·9 (914).	April 2, 1913, 44444/44400.	44.
				April 19, 1913, 0·9 (914).	Sept. 24, 1913, 44443/43000.	...
				Sept. 23, 1913, 0·9 (914).	May 13, 1914, 44430/40000.	3½.
123.	P. H.	34	Gastric crises. A.R. pupils. K.J. and A.J. good.	Sept.-Oct. 1913, 3 doses 0·9 (914).	Sept. 17, 1913, 44444/44400.	...
					June 25, 1913, 44443/44410.	13; 1 per cent. polymorph.
124.	E. I.	55	Tabes dorsalis, 23 years. Charcot knee (stationary).	April 10, 1913, 0·9 (914).	Mar. 5, 1913, 0/—.	...
					April 9, 1913, 20000/0.	1.
					April 18, 1913, 22000/0.	...
					April 22, 1913, 22000/0.	0·3.
					April 29, 1913, 20000/0.	1.
125.	F. K.	37	Taboparesis (P.M.).	May 17, 1913, 0·9 (914).	April 16, 1913, 44442/44440.	44; 1 per cent. polymorph.
				May 20, 1913, 0·9 (914).	Oct. 8, 1913, 44444/44300.	6.
				May 26, 1913, 0·9 (914).		

GROUP IVc. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
126.	H. Kn.	55	Sc. encephalitis (treated). Now in asylum.	Oct. 7, 1912, 0·6 (914).	Oct. 2, 1912, 44440/44100.	...
					Nov. 5, 1913, 4——/0.	½; *c.* bacteria.
127.	T. M.	38	Dementia paralytica. Now in asylum.	Oct. 16, 1913, 0·9 (914).	Oct. 15, 1913, 4——/—.	...
				Oct. 22, 1913, 0·9 (914).	Oct. 22, 1914, 44444/44444.	80; 4 per cent. polymorph.
				Nov. 1, 1913, 0·9 (914).	Feb. 18, 1914, 44444/44444.	3.
				Feb. 4, 1914, 0·9 (914).	May 18, 1914, 44420/44444.	2.
128.	M. M.	...	Sc. hemiplegia, with relapse and development of psychosis.	Oct. 5, 1912, 0·9 (914).	Oct. 2, 1912, 44310/42000.	...
				Oct. 9, 1912, 0·9 (914).	Nov. 25, 1913, 44410/44300.	67. 1 per cent. polymorph., 2 per cent. mast cells.
129.	W. M.	58	Secondary optic atrophy. Old Sc. meningitis.	...	May 21, 1913, 4——/—.	...
					June 18, 1913, 44410/10000.	20.
130.	D. S.	53	Tabes dorsalis.	Hg.	Dec. 14, 1911, 44410/44400.	...
				May 7, 1913, 0·9 (914).	May 7, 1913, 44442/44100.	21; (heart antigen). 6.
131.	A. S.	28	Tabes dorsalis and optic atrophy. S.I., 1905.	Hg. 2 years.	Nov. 20, 1912, 44442/44300.	...
				Nov. 15, 1912, 0·9 (914).		
				Nov. 17, 1912, 0·9 (914).	Oct. 15, 1913, 44444/44100.	6.
				Nov. 19, 1912, 0·9 (914).		
132.	A. Ss.	36	Cerebro-spinal S. S.I., 1896.	Feb. 1914, 0 9 (914).	Nov. 5, 1913, 4——/—.	...
				Mar. 1914, 0·9 (914).	Feb. 25, 1914, 44443/44444.	
				Mar. 1914, 0·9 (914).	May 15, 1914, 44440/44410.	7.
				Apr. 1914, 0·9 (914).		
134.	F. S.	39	S. meningo vascularis. S.I., 14 years ago.	Has had Hg.	Nov. 12, 1913, 44444/44444.	30.
					Dec. 9, 1913, —/44444.	4.
135.	W.G.T	35	Dementia paralytica. Onset with manifestations of basal meningitis (progressive).	Hg. Jan. 25, 1913, 0·9 (914).	Jan. 22, 1913, 44430/44441.	50.
				Jan. 31, 1913, 0·9 (914).	Oct. 15, 1913, 44440/44444.	39; 5 per cent. swollen.

GROUP IVc. (*continued*).

Case No.	Initials	Age.	Diagnosis.	Treatment.	W.R.	Cells per c.mm.
				Feb. 5, 1913, 0·9 (914). Oct. 13, 1913, 0·9 (914). Nov. 14, 1913, 0·9 (914). Nov. 18, 1913, 0·9 (914). June, 1914, 0·9 (914). June, 1914, 0·9 (914).	June 10, 1914, —/44444.	38; 7 per cent. swollen.
136.	G. W.	36	Paralysis of 3rd cranial nerve and crossed hemiplegia (Weber's syndrome). Sc. rash, Mar. 1913.	Hg. and 914.	Mar. 18, 1914, 0/41000.	30.
					May 8, 1914, 0/—.	...
					May 13, 1914, 0/0.	13.
137.	F. W.	45	Post-syphilitic amyotrophic lateral sclerosis.	2 doses "606," 1913.	Jan. 1913, 4——/—.	...
				Aug. 2, 1913, 0·9 (914).	Aug. 6, 1913, 44200/44000.	...
				Dec. 3, 1913, 0·9 (914).	Dec. 3, 1913, 43000/44000.	...
				Dec. 4, 1913, 0·9 (914).	Mar. 4, 1914, 44300/—.	...
				Dec. 8, 1913, 0·9 (914).	May 5, 1914, 42000/42000.	3.
				Mar. 4, 1914, 0·9 (914).	...	...
				May 5, 1914, 0·9 (914).	...	...
138.	V. W.	...	Pseudo-paresis syphilitica, improved under treatment.	3 times 0·9 (914) in Nov. 1913.	Nov. 26, 1913, 44444/44444.	14; 3 per cent. plasma cells.
					June 10, 1914, 44441/44443.	9.
139.	J. Z.	40	Sc. disseminated sclerosis. Onset 1909.	Much Hg. and KI. Dec. 22, 1913, 0·45 (914).	Dec. 3, 1913, 0/0.	3.
					Dec. 30, 1913, 0/—.	...

SUMMARY.

The drop-film method of counting the cells of cerebro-spinal fluid is described, and more than 260 cell-counts, from cases dealt with by Drs M'Intosh, Fildes, Head, and Fearnsides[1] are discussed in connection with extensive tables lent by those authors to show the quantitative Wassermann test, done two to five times on the

[1] *Brain*, Vol. xxxvi., Part i., July 1913, and following numbers.

c.s.f. simultaneously with the cell-count, and oftener on the serum, in a number of cases in various stages of treatment.

The method avoids centrifuging, which is found to cause loss of some cells, especially of the swollen degenerated cells. (These exist in some freshly drawn c.s.fs., and they develop from unswollen cells in c.s.f. kept for a day or two.) Also it avoids the addition of alcohol or of acetic acid, substances that destroy the red cells. (Red cells, whether due to the puncture or due to previous hæmorrhage are, as Rous insisted, to be demonstrated and allowed for.) No special apparatus is used. The preparations are permanent, and may be easily multiple, *e.g.*, for class purposes.

On each of any number of ordinary slides a couple of separate small drops of the c.s.f. are deposited by the simple dropping pipettes described[1] recently in a short communication to the Royal Society. The slides are then dried, heat-fixed, dipped in dilute collodion, and dried again. Thus are obtained drop-films that are practically collodion sections at most only one dried cell in thickness. These films, stained, *e.g.*, Giemsa, or Leishman, and Unna-Pappenheim, and mounted in clear soft paraffin, give, with the aid of a mechanical stage, at once clear cell-pictures and convenient accurate cell-counts, without the loss of a single bacterium. Staining for Gram-positive bacteria or for tubercle bacilli may be done.

At any stage after the drying of the drop the process may be interrupted, at the worker's convenience.

When filed (*e.g.*, by a "slide-index" method, to be described later), the permanent preparations give a valuable record of the cytological course of the case.

The cases dealt with are marked off into four groups by the serum-W.R. and the cell-count. The main interest centres in group IV., with serum-W.R. positive and with pleocytosis. Only this group has the c.s.f.-W.R. positive.

In many of the patients at the time of first observation it is impossible to say whether the condition is to be called "cerebro-spinal syphilis," and a hopeful prognosis given, or whether it belongs, or may presently, especially if no treatment now be applied, belong to the clinical group "parasyphilis," with its relatively hopeless prognosis. Not by the presence or by the degree of pleocytosis—any more than by the presence or by the strength of the W.R. in c.s.f. or in serum—but only by their

[1] Donald, *Proc. Royal Society*, B, 1913, Vol. lxxxvi., p. 198.

behaviour under treatment do these cases show up as belonging to the one type or to the other. The potency, in many of the cases, of treatment by intravenous injections of neosalvarsan is indicated in the tables of successive cell-counts and Wassermann tests.

In subsequent articles the authors mentioned will show that in the cases of sub-group IV*b*. ("cerebro-spinal syphilis") the fall in the W.R. and in the cell-count is followed by actual improvement in function, which improvement in some cases proceeds to the recovery of good bodily health with some mental improvement, and in other cases to practically complete recovery. Moreover, they will show that, even in sub-group IV*c*. ("parasyphilitic" group) considerable clinical improvement takes place in some cases, corresponding, no doubt, to some arrest of the inflammatory processes, though not to resolution of any secondary degenerations.

As the published tables show, the cell-count is a test that, for significance and reliability, is a worthy co-operator with the W.R. Indeed it often gives earlier than the W.R. (1) warning of meningeal affection, and (2) after treatment, indication of improvement.

The pleocytosis-producing substance is shown to be distinct from the Wassermann substance.

A description is given of a simple microscope lamp, which has shown itself of value in rapid qualitative cell-counts, with moderate powers.

Besides the mainly-used drop-film method, there is described a simple drop-chamber method, using ordinary slides and cover glasses, and suitable for dark-ground examination of unstained cells.

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