A CLINICAL EXAMINATION
of the
CEREBRO-SPINAL FLUID
IN 225 CASES OF INSANITY

being

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INTRODUCTION.

So much work has been done in connection with the cerebro-spinal fluid in recent years that I feel that my choice of subject demands some explanation.

I have approached the subject entirely from the point of view of a clinician, my purpose being to show that for diagnostic purposes a reliable examination of the spinal fluid can be made without the examiner having any special pathological training, or a well equipped laboratory at his disposal.
HISTORICAL.

The existence of the cerebro-spinal fluid was noted as early as 1769 by an observer named Cutugnuo(1). He described it as being a limpid and transparent fluid, like spring water, which bathed the nervous centres. In addition to finding it in the human body, his researches were also successful in the fish and turtle. It is a curious fact that he failed to observe it in the dog. Why, one does not know.

At this point, interest in it seems to have died out, judging from the fact that 60 years are allowed to elapse before anything further of importance is heard of it. Then in 1825 Majendie(2) published a description of the cerebro-spinal fluid (as he calls it), a description which is quoted today. He writes not only about the fluid, but also concerning its movements, its origin and the nature of its pressure.

We cannot help being struck by the scarcity of observations on this subject at this period. The reason is, I think, not difficult to find. Lumbar puncture had not yet been introduced, and there was of necessity great difficulty in obtaining the fluid. Some was no doubt obtained post mortem, but the only
opportunities of obtaining it during life occurred in pathological conditions, such as meningoceles, &c.
where the quantity obtained was of necessity small, and often tainted by foreign material.

In 1858, Claude Bernard\(^3\) discovered the presence in the cerebro-spinal fluid of a substance that reduced Fehling, and which he called glucose. Following this, many Continental observers published their findings - men such as Berzelius\(^4\), Mulder\(^5\), Marcet\(^4\), C. Schmidt\(^5\), Méhu\(^6\), Hoppe-Seyler\(^7\), Yvon\(^4\), Müller\(^6\) and Lassaigne\(^9\). Most notable among these is Hoppe-Seyler, who seems to have been the first to point out that the protein present was globulin, and who first described the faint cloudiness produced by boiling normal cerebro-spinal fluid which had previously been rendered slightly acid.

In 1885, and again more fully in 1889, Halliburton\(^10\) published his analysis of several cases collected over a period of about four years. The fluid was obtained from meningoceles and cases of hydrocephalus, and in one myxoedematous patient, from the ventricles after death. He was able to point out that the proteid was serum globulin, and he showed that it was precipitated by saturation with Magnesium Sulphate. He also stated that the reducing substance was pyrocatechlin, an opinion
which he has since then refuted. He agrees with C. Schmidt in considering the cerebro-spinal fluid as a secretion rather than an exudation - the exceptional character of its proteid alone being sufficient to render it distinct from these fluids.

In 1881, Quincke\(^{(1)}\) discovered the possibility of drawing off the cerebro-spinal fluid during life - a procedure to which he gave the name of lumbar puncture. He meant it to be a therapeutic measure to relieve pressure symptoms in meningitis. This was the only therapeutic indication for the operation intended, though it has been tried on many other conditions with varying results. Sometimes the cases seem to have benefitted; on other occasions no result has been noticed; while in a few harm has been done. It has been tried in cerebral abscess, in Huntington's Chorea, and even in cases of cerebral tumour. In this latter condition, many adverse results have been obtained, so much so that many observers consider that the presence of a cerebral tumour is a contra-indication for the operation. These disasters have undoubtedly been due to the sudden diminution of an increased intracranial pressure. It has been tried for epileptic attacks, the seizures of general paralysis of the insane, and Status Epilepticus with reported good results, and
the pains of tabes dorsalis have been said to have been relieved after the operation. Marie\(^{(12)}\) mentioned it as a successful therapeutic measure for the relief of headache due to secondary syphilis. In the hallucinatory delirium of Bright’s, Vigoreux\(^{(12)}\) has seen it cause relief. Babinski\(^{(12)}\) has seen it employed with favourable results in cases of disturbance of hearing with increased intracranial pressure.

Two very curious cases\(^{(12)}\) are worth mentioning. The first, reported by Moty, is a case of catatonic stupor following scarlatina in a soldier aet. 19. After two punctures, at each of which 5 c.c. were withdrawn, the patient entirely recovered. The second - reported by Mehler - is a case of chronic hydrocephalus; 300 c.c. were abstracted at two sittings, the needle being left in till the fluid ceased to flow. The patient benefitted.

In recent years it has been tried with varying success in cases of cerebro-spinal meningitis.

In spite of these results, there is no doubt that lumbar puncture, as a therapeutic measure, has been a failure, if one excepts its employment in spinal anaesthesia. It is as a means to diagnosis that it was and still is of the greatest importance - an importance that has more than justified its
existence. As the fluid was easily obtained and the operation not dangerous, a large field for investigation was at once opened up. The subject became a popular one, with the result that the normal constituents of the fluid were soon confirmed and elaborated.

In 1896, Badcock (13) found the proteid increased in twelve cases of general paralysis, and in 1897 Nawratski (14) confirmed this in six cases. Schaefer (15), in January 1902, refers to these cases and was the first to realise the importance of the discovery. By 1901 lumbar puncture was in general use for the purposes of diagnosis in neurology and psychiatry. In addition to an increase in proteid, an increase in the cell content had been noticed, and such observers as Widal and Ravaut, J. Naquotte, Duplos, Séglas, devoted much time to the study of the fluid and published interesting results.

From this date interest in the subject quickly grew, and contributions to our knowledge of the cerebro-spinal fluid were published in all parts of the scientific world. This has resulted in an enormous accumulation of literature. In consequence of this, the routine examination of the cerebro-spinal fluid is carried out in many Mental Hospitals on every new admission simply because of its value
as a diagnostic measure.

Simple tests have been prepared, simple methods of cell counting have replaced the slow and less accurate ones, and a clinical examination of the fluid has been placed within the reach of any medical practitioner without the need of any elaborate apparatus.
DESCRIPTION OF POSITION OF CEREBRO-SPINAL FLUID.

The cerebro-spinal fluid occupies the meshes of the subarachnoid space, the ventricles of the brain, and surrounds the intra-cerebral blood vessels down to their smallest branches. By means of the Foramen of Majendie in the roof of the fourth ventricle, the fluid finds its way from the brain into the spinal canal, from which double relationship it is named. Each nerve as it leaves the cerebro-spinal axis is surrounded by this fluid, so that the whole nervous system is continually bathed in it. This is naturally an important point from a physiological and pathological standpoint.

The chief function of the fluid seems to be to compensate for any changes in the size of the brain that may occur. Such changes normally occur during the systole and diastole of the heart. During systole, an increase of the flow of blood to the brain occurs - the brain increases in size - and to make room for such increase the cerebro-spinal fluid recedes into the spinal canal and along the nerve sheaths.

The contrary occurs during diastole. The blood leaves the brain, which becomes in consequence smaller, and the cerebro-spinal fluid flows out to
fill up the space that is left. Thus the intracranial pressure is maintained.

Pathologically, as in cases of cerebral haemorrhage, abscess, tumour or depressed fracture, the increase in the size of the brain is accommodated and compensated for by a diminution of the quantity of cerebro-spinal fluid. This, of course, is true only up to a certain point.

As regards the spinal cord, the function of the fluid is largely one of protection. The cord hangs suspended and surrounded by this fluid, which lessens the effect of shock and keeps the delicate and sensitive cord from harsh contact with its bony canal.

Finally, its role in concussion is worth mentioning. Duret\(^{18}\) pointed out that concussion was caused by stimulation of the restiform bodies by a wave of cerebro-spinal fluid which had been driven to the base of the brain by the force of the blow. This sudden stimulation produces a profound anaemia of the brain, to which the symptoms are directly attributable.
DESCRIPTION OF CEREBRO-SPINAL FLUID.

The cerebro-spinal fluid is a fluid sui generis for its physical and chemical properties are different from those of any other fluid in the organism. It approaches in its composition most nearly the sweat and tears. The normal fluid is clear like water. The specific gravity is 1006-1008. The cryoscopic point of the fluid is from -0.51° to -0.56° C. - that is to say, the temperature of the spinal fluid is very near that of blood (-0.56°C). It is, practically speaking, devoid of all corpuscular elements, and it contains only traces of protein matter, becoming only very slightly turbid on heating. In reaction it is alkaline, the alkalinity being only half that of blood (Cavazzini\(^{(17)}\)).

Various analyses of the salts show that the principal constituent is Sodium Chloride, but it also contains traces of carbonate, bicarbonate, phosphates, and a reducing substance which is generally looked upon as being glucose.

As regards the nature of the proteid present, the consensus of opinion seems to be in favour of its being globulin and globulin alone (Arthus\(^{(18)}\), Guillain and Parant\(^{(19)}\), Halliburton\(^{(10)}\), Mott\(^{(20)}\), Hoppe-Seyler\(^{(21)}\), Nawratski, Renon and Texier\(^{(15)}\),
Sicard(24), Siemerling(25) and Sollman. Halliburton(10) states further that it consists of serum globulin - not fibrinous or cell globulin - and that it coagulates at 78°C. Ernest Jones(27) considers the globulin present an unusual one and calls it eu-globulin. The amount present normally is very small - about 0.25 grammes per litre (Gumprecht(28)).

The normal fluid is practically free from cells, 1 per cmm. by most authorities being given as the amount. The type of cell is a lymphocyte, of the large and small variety. According to Ernest Jones(29) anything over 1.5 per cmm. must be considered pathological.

The gases it contains have been worked out by Mott(30). By boiling in vacuo, Carbon Dioxide, Oxygen and Nitrogen were all found. By the addition of an acid, and then heating in vacuo, more Carbon Dioxide is obtained than by simply heating. Thus the amount of Carbon Dioxide in unstable composition is comparatively small. Compare this with ordinary blood serum. In blood serum, after boiling in vacuo, the yield per cent. is 46 by volume. In cerebro-spinal fluid it is only 10%. Thus it would appear that the Carbon Dioxide in the cerebro-spinal fluid is more stable than it is in the blood.

The composition of the fluid is against it
being a transudation from the blood or a lymphatic secretion, and Mott (31a) has mentioned the following facts in support of this:

1. It contains 0.02% of proteid against 7% in blood plasma.
2. It contains 0.02% of proteid against 4.5% in body lymph.
3. There is an absence of lipochrome.
4. There are no leucocytes in the normal fluid.
5. In enteric fever there is an absence of agglutinins.
6. It has no haemolytic action on the blood corpuscles of other animals.
7. It contains no alexins.
8. Absence of bile in cerebro-spinal fluid in cases of jaundice.
9. Amyl Nitrite produces no increase in rate of flow.
10. Drugs administered by mouth or subcutaneously do not pass into the cerebro-spinal fluid.

There are two exceptions to this which should be mentioned:

(1) Majendie believed that Potassium Iodide given by the mouth passed into the cerebro-spinal fluid. He published observations in support of this, and was of the opinion that this explained
the benefit obtained after taking Potassium Iodide in certain diseases of the nervous system. Most observers who have worked at this have been unable to confirm it.

(2) Ager(31) recently made the discovery that urotropine passed into the cerebro-spinal fluid and could be employed with benefit in cases of meningitis. It seemed to have a marked anti-bacterial effect, and was found to make its appearance in the cerebro-spinal fluid between half-an-hour and an hour after ingestion. Experiments on animals confirmed this.

The source of the fluid is still open to doubt. Mott(30) believes that it is secreted by the choroid plexus in the lateral ventricles. This theory is a most popular one, and there is considerable evidence in favour of it.

Examined microscopically, we find that the choroid plexus consists of vascular tufts surrounded by a connective tissue stroma and covering this a single row of cubical, spheroidal or polyhedral cells as a basement membrane. It is these cells that have the appearance of being secretory agents, and they compare most favourably with the cells in the lachrymal gland. The histological evidence is all in
favour of the choroid plexus being a gland with an external secretion which has an internal destination. It would therefore be intermediate between a gland with a duct and a ductless gland.

If this be the origin of the cerebro-spinal fluid, its unique chemical composition and freedom from cells are more easily understood.

The secretion is undoubtedly continuous, as shown by the many clinical cases on record, when, owing to perhaps a fracture of the base of the skull, large quantities of cerebro-spinal fluid have drained away in the twenty-four hours (Billroth(32), Verneuil(32), Routier(32), Tillaux(32)). Halliburton(33) Hill(33) and St. Clair Thomson(33) have recorded loss of large quantities by dripping from the nose.
THE PATHOLOGY OF THE CEREBRO-SPINAL FLUID.

It may be advisable here to refer briefly to the pathological changes that may occur in the fluid. These may be ascertained by three means:

(1) Naked Eye.
(2) Chemistry.
(3) Microscope.

(1) THE NAked EYE PATHOLOGY.

It is unusual to find the appearance of the cerebro-spinal fluid altered. In inflammatory conditions it may be turbid, serous or even purulent. What is most often seen, however, in respect of change of colour, is a red tinge due to the admixture of blood withdrawn during the operation. Less often the colour may be brown, due to altered blood from an old haemorrhage.

Pressure.

The normal pressure is about sixty drops per minute - the drops escaping from the needle at that rate. In cases of excitement, and again in general paralysis, the pressure may be so great that the fluid escapes in a thin jet. In the former case this is probably due to the increased vascular tension; in the latter, probably to the large excess
of the fluid found in that disease. I have seen a patient who had commenced straining during the operation so increase the pressure that it has escaped for a short time in a jet in place of the normal dropping. Coughing, laughing or sobbing may have the same effect on the flow. Richter(34) believes that these variations in pressure are largely influenced by external conditions, (1) the place where the dural sac is pierced, whether in the middle or at the side, and (2) by the size of the needle.

(2) THE CHEMICAL PATHOLOGY.

Protein.

In acute and chronic inflammatory conditions, in fact in any condition where there is a leucocytosis, there is excess of globulin, and albumen and nucleo-proteids are present. In cases of progressive degeneration, the amount of the proteid is greatly increased. The excess, according to Mott, consists chiefly of globulin, but albumen and nucleo-proteins are again to be found. As regards the variations in the amount of sugar, more will be said later.

Cholin.

According to Mott and Halliburton(35), cholin
is essentially a pathological constituent of the cerebro-spinal fluid. Its presence is apparently consistent with degeneration of a large amount of nervous tissue. Some authorities (Swale Vincent) question the reliability of the test employed and seem to doubt whether the substance found is really cholin or some other product of the cleavage of the complex phosphatide molecules. The small quantity present greatly increases the difficulties of examination, and it will be necessary to bring forward more evidence in order to arrive at reliable conclusions.

(3) THE MICROSCOPICAL PATHOLOGY.

By means of the microscope one can detect pathological conditions by the presence of -

(a) Cells
(b) Bacteria
(c) Protozoon.

(a) Cells we find:

I. Polynuclear Leucocytosis.

This generally indicates microbic invasion of the subarachnoid space other than by the tubercular
bacilli. It must, however, be remembered that even in tubercular infection one may sometimes find a polymuclear leucocytosis accompanying the lymphocytosis.

II. Mononuclear Leucocytosis.

This indicates a chronic infection in contrastinction to a polymuclear leucocytosis, which is the invariable accompaniment to an acute inflammatory infection of the meninges. It occurs almost constantly in syphilis of the central nervous system, general paralysis, tabes dorsalis, tubercular meningitis and sleeping sickness. It has also been recorded in cases of Herpes Zoster, acute poliomyelitis, mumps, lymphatic leukaemia, chloroma, and some cases of cerebral tumour. In the later stages of microbic infection, it may be found that the mononuclears have replaced the polymuclears. This occurs in some cases of cerebro-spinal meningitis.

III. The Epitheloid Cell.

This is often larger than the polymorph, being sometimes over 12" in size. It is of irregular shape, and of very rare occurrence - probably an accidental inhabitant.
IV. Plasma Cells.

These are usually elliptical, but they may be round. The nucleus occupies an eccentric position and stains rather deeply with clearly defined edges, sometimes the most striking element present; by some considered pathognomonic of general paralysis (Cotton & Ayer(37)).

V. Degenerated Cells -

The so-called "clear elements", 10"-15" in size, of frequent occurrence and stain with difficulty or not at all, except for small traces of chromatin irregularly placed. It may be mentioned that these cells occur typically in general paralysis. They may also be found in cases of tabes and cerebral syphilis. Possibly they exist in any case which gives a definite lymphocytosis of the cerebro-spinal fluid.

VI. "Körnchen" Cells -

A phagocyte cell filled with numerous fat droplets or fatty pigments. These are only found post mortem.

The best method of making a differential examination of these cells is that of Alzheimer(38). He adds alcohol to the fluid, centrifuges it and hardens coagula with alcohol. He then puts the hardened coagula in Celloidin (first thin and then
(b) **Bacteria:**

The most important organisms are *pneumococcus*, *streptococcus*, *bacillus tuberculosis* and the *diplococcus intracellularis* of cerebro-spinal meningitis. Other organisms may be found in conjunction with the *pneumococcus* and *streptococcus* as a result of secondary infection.

(c) **Protozoon:**

*Trypanosoma Gambiensi* of the sleeping sickness is the only one found. *Treponema Pallidum* has been found once.

**METHOD OF LUMBAR PUNCTURE.**

The puncture may be made with the patient either lying on his left side or seated on a low stool. In the former position, the spine should be fully flexed by approximating the shoulders and knees. In the latter position, the same result can be obtained by asking the patient to lean forward with his elbows...
on his knees. By these means the vertebrae are separated as much as possible, and the spinous processes become more prominent.

The space between the fourth and fifth lumbar vertebrae is that commonly utilised for this operation because it is usually the widest and affords the easiest entrance.

In order to identify the space, one must draw an imaginary horizontal line across the back from the highest point of the one iliac crest to a corresponding point on the other. This line crosses the column at the level of the upper edge of the fourth lumbar spine.

After the skin has been thoroughly cleansed, a sterilised needle of platinum (in order to lessen the risk of breaking) and about three inches long is introduced in the middle line, about half an inch below the fourth lumbar spine. It is passed forwards and slightly upwards.

The needle usually encounters some resistance as it pierces the Ligamentum Subflavum, but after this has been overcome it enters the subarachnoid space and the fluid escapes.

A sterilised stilette should be used to clear the needle when necessary.

The presence of blood in the fluid renders it
useless for examination. Great care should therefore be exercised to avoid this accident. Occasionally it is unavoidable, and the patient should be given at least a week’s rest before any further attempt is made.

The after effects of this operation are not serious, provided reasonable precautions are taken. Everything must be thoroughly aseptic, as little fluid withdrawn as possible (about 6 c.c. is sufficient), and the patient kept in bed for forty-eight hours afterwards.

These precautions were taken in the cases referred to in this paper, and there were only a few instances where it was found that the patients suffered from slight headache and sickness. Neglect of these precautions may result in most alarming effects, especially in cases of cerebral tumour. It has even been known to prove fatal(39).

It was interesting to note the marked sedative effect lumbar puncture had when performed on restless and noisy cases. The operation was carried out purely for diagnostic purposes, and one could not for a moment advocate it as a therapeutic measure for restlessness. The sedative effect, though marked, did not usually last long - in no case longer than twenty-four hours.
DESCRIPTION OF METHODS EMPLOYED.

The examination of the cerebro-spinal fluid in this paper was carried out on the following lines:

1. Proteid - Qualitative examination for -
   (a) The Ross-Jones Test
   (b) The Nonne & Apelt Test
   (c) The Alcohol Test
   (d) The Carbolic Test
   (e) The Noguchi Test

2. Proteid - Quantitative Examination for Aufrecht's Albuminimeter.


4. Reducing Substance.
   (a) Rough Estimation in various Insanities.
   (b) Quantitative Estimation in 20 Cases of General Paralysis - The Gravimetric Method.

It would be advisable to consider these more fully.

1. The Qualitative Examination for Proteid.
   (a) The Ross and Jones Test(40).
This test was introduced by Doctors G. W. Ross and Ernest Jones and is a modification of the Nissl-Nonne Saturated Ammonium Sulphate Reaction. It consists in the addition of clear cerebro-spinal fluid to a saturated solution of Ammonium Sulphate gently, so that the fluid lies on the reagent without blending with it. The quantities used were 1 c.c. of the reagent and .75 c.c. of the fluid. The fluid was allowed to slowly trickle down the side of the test tube on to the reagent. The tube was then allowed to stand.

It will at once be seen that this test closely resembles the strong nitric acid test for albumen in urine.

When positive, a sharply defined thin, white film marks the junction of the two fluids. Within half-an-hour, delicate processes - like particles of cobweb - detach themselves from the under surface of the film and slowly sink to the bottom of the tube. This is an important part of the positive reaction.

When the ring is faint and after half-an-hour is still compact, then the reaction is partial.

Those responsible for the introduction of the test affirm that it is only positive in general paralysis, tabes, tertiary syphilis and syphilis of the nervous system.
(b) The Nonne and Apelt Test (41).

Equal parts of cerebro-spinal fluid and a saturated solution of Ammonium Sulphate are taken and shaken up in a test tube. The tube is then allowed to stand. When positive, a definite precipitate is noticed within three minutes. When the precipitate is faint, the test may be said to be partial.

The part described is called Phase 1, and is the most important part of the test and, practically speaking, the only part worth carrying out for diagnostic purposes.

After Phase 1 has been completed, the same specimen is used for Phase 2. This consists in filtering, acidulating and boiling, and observing the resulting precipitate. Nonne found Phase 1 positive in 100% of general paralysis and in 96% of his cases of tabes and syphilis of the cerebro-spinal system. He concludes of Phase 1 that:

(1) It is positive in all cases where there is an increase of cells in cerebro-spinal fluid.

(2) It may occur in non-syphilitic cases where there is a lymphocytosis.

(3) It is absent in clinically cured syphilis.

(4) It is absent in functional neurosis even if there is a history of syphilis.
(c) The Alcohol Test.

This test is based on the well known fact that alcohol will precipitate proteid. For this test 96% alcohol is used as the precipitant. Equal parts of the reagent and fluid are taken, as in the Nonne and Apelt test. An arbitrary standard is made by taking the turbidity produced in a volume of fluid of an advanced case of general paralysis as 10, and with this as the standard, the turbidity of the others is compared and measured. A normal fluid will always produce a slight opalescence which is called 1 and is of course considered negative. This is due to the small amount of proteid normally present. From 1-6 is considered a partial reaction, and anything above 6, positive. The method is, of course, very arbitrary, and a little experience is necessary in judging the extent of the reaction.

(d) The Carbolic Test. (42)

Four per cent. carbolic acid is used. 1 c.c. of carbolic acid is taken in a test tube. To this is added one drop of the cerebro-spinal fluid. The test tube is allowed to stand and must not be shaken. When positive, the drop of fluid soon becomes greyish in colour, and is then in striking contrast to
the clear reagent. Sometimes the reaction begins as soon as the two fluids come in contact. The course of the fluid to the bottom of the tube can easily be traced. The test is a pretty one and easily performed.

(e) The Noguchi Test.\(^{43}\)

\(\cdot2\) c.c. of spinal fluid is added to \(\cdot5\) c.c. of 10\% butyric acid solution. This is boiled for a few seconds. To this is then added \(\cdot1\) c.c. of normal solution of Sodium Hydrate and the whole once more boiled; the tube is then put aside to cool, and the density of the resulting precipitate noted. A slight precipitate constitutes a partial reaction. Accurate measurement of quantities is absolutely necessary, and the test should be performed without any pause between the steps.

For these tests to be successful it is absolutely necessary that the specimen examined should be free from blood, since the proteid in blood complicates matters and renders accurate judgment impossible. This is especially true of the Carbolic Acid Test.

A "Partial" Reaction:

While it is true that whenever the reaction is
obtained the presence of globulin is demonstrated, it is also equally true that the quantity of globulin present may vary considerably and so admits of the term "partial" being applied to those reactions demonstrating small quantities.

2. Proteid Content - Quantitative Estimation for Aufrecht's Albuminimeter (44)

Devised by Dr Aufrecht of Berlin and intended to enable practitioners to estimate the quantity of albumen in urine quickly and accurately. It has been used for a similar purpose with the cerebrospinal fluid and the results are most satisfactory. The apparatus consists of a cylindrical strong reagent tube fitted with a rubber cork. It is narrower at the bottom than at the top and is graduated. The highest mark is R, next comes U, lower down the figures 1.7%, 1.6%, 1.5% and so on, down to 0.01% at the very bottom.

The fluid is poured in up to the mark U, then the reagent (consisting of 5% Picric Acid and 3% Citric Acid) up to the mark R. The tube is then closed with the rubber cork and the two fluids mixed by inverting the tube. It is then placed in a centrifuge and centrifuged for 2 minutes (5000 times
per minute, or 3 minutes at 2000 times per minute). When taken out of the centrifuge the percentage of precipitate is then seen accurately marked on the lower part of the tube.

3. Cytology.

In connection with the cerebro-spinal fluid, the cases requiring a cytological examination may be divided into two distinct groups, namely:

(a) Those in which the cells are present in great excess, producing even turbidity, as in meningitis;

(b) Those in which the increase is comparatively slight, as in general paralysis.

In the first group, no centrifugalisation is necessary. The cells are often as numerous as the leucocytes in the blood, and a method of counting may be used similar to that employed in doing a white count.

Ernest Jones Method. (29)

The second group is of greater interest. Here the cells are comparatively few and the centrifuge is used to obtain a sufficient concentration for accurate counting. A centrifuge tube graduated in
cubic centimetres, with the first cubic centimetre divided into tenths, is employed. Into this three cubic centimetres of the fluid are titrated. It is then centrifuged for a quarter-of-an-hour at a speed of at least 2000 per minute. Taking great care not to approach the bottom of the tube with the pipette, one draws off the fluid until it stands at 6 c.c. This means that only one fifth of the original fluid is employed and is a concentrated emulsion of cells and fluid. The result of every count has therefore to be divided by five in order to get the average of the normal fluid. A drop of the fluid is then placed on an Abbé-Zeiss slide, with the pipette and the cover glass put in position.

The counting is done by fields. The diameter of the field employed is $7\frac{1}{2}$ squares - the ordinary little square of the Abbé-Zeiss slide. The half is marked off by that vertical line which bisects certain squares and whose function it is to aid in the dividing off of sets of sixteen squares.

Such a diameter is chosen for the following reason. It was found that a field whose diameter was $7.5$ squares corresponded to $1/90$ of a cubic millimetre.
Therefore if 90 of these fields were counted one would know the amount of cells in a cubic millimetre of the emulsion.

The 90 fields are obtained by using three separated drops and counting 30 fields in each. The results are then added and divided by five (see above) and one thus obtains the amount of cells in one cubic millimetre of the fluid under examination.

In judging the value of this method it is well to remember that counting 90 fields is equivalent to counting 4000 squares, since 4000 squares are equal to 1 cubic millimetre.

4. Reducing Substance.

This reducing substance is now generally believed to be glucose.

(a) Rough Estimation in Various Insanities.

A definite quantity of Fehling's Solution (0.5 c.c.) was taken and boiled. To this was added 0.25 c.c. of the fluid to be examined and the whole reboiled. If a colour change was noticed, the test was finished and 0.25 c.c. of the spinal fluid was noted as reducing 0.5 c.c. Fehling. This constituted the standard of comparison. If, on the other hand, no reduction occurred, more cerebro-
spinal fluid was added - in quantities of .1 c.c. - until a change of colour was observed. The contents of the test tube were boiled after each addition of fluid.

By this means a rough idea was obtained as to the variation of the reducing substance in different kinds of insanity. Though never absent, it was found to vary considerably in different cases.

(b) The Gravimetric Method (modified)(44).

After centrifuging for cells, 10 c.c. of the cerebro-spinal fluid is taken, placed in a 200 c.c. beaker, slightly acidified with a drop or two of tartaric acid solution and made up to 50 c.c. with absolute alcohol. The mixture is then gently warmed to precipitate the proteid present. This takes about 5 minutes. The proteid is then filtered off and the filter paper carefully washed with 75% alcohol in order to ensure no loss of fluid. It is best to pour the fluid down a glass rod and let it drop into the filter paper. By this means no fluid is lost by trickling down the side of the beaker.

The alcohol is then evaporated and the residue dissolved in 30 c.c. distilled water. To this solution - which has been heated - is added a boiling mixture of 25 c.c. combined Fehling Solution and
40 c.c. distilled water. This mixture is then boiled for 10 minutes and then filtered, the filtrate, which is cuprous oxide, being retained in the filter paper. A specially prepared filter paper was used, its advantage being its strength, its excellent filtering properties and the fact that when burnt its ash is so light as to be negligible.

(Charta Filtratoria Hydrochlorico et Fluorico prepared by Schleicher & Schull.) The filtering is done as on the previous occasion, but the washing is carried out with boiling distilled water. The paper is then allowed to dry. When dry, it is wrapped up and put on a crucible which has been previously weighed. It is then incinerated over a Bunsen flame and allowed to cool in an air-tight chamber containing dilute sulphuric acid to absorb the moisture from the air. Cupric acid is hydroscopic and if allowed to absorb moisture - will naturally increase in weight. When cool enough to permit one to handle it, the crucible is weighed again. The difference between the two weights represents the amount of Cupric Oxide reduced by the glucose in 10 c.c. of the fluid. To convert the weight of Cupric Oxide into terms of glucose, one must multiply one's result by '4535, which is the generally accepted factor for glucose and cupric oxide. The
percentage is easily gained by dividing by 10 - the amount of cerebro-spinal fluid taken - and then multiplying by 100, since 10 c.c. are taken. A shorter method is simply to multiply by 10.

By this method the fluids from 20 cases of general paralysis were examined. The average result obtained was .09%. This result is slightly lower than that obtained by Mott, who used the same method, without, however, employing filter paper to retain the cupric oxide. He used a Gooch crucible instead. This slight difference in method may possibly account for the slight difference in results.

The Presence of the Reducing Substance.

The cases were lumbar punctured in the mornings and the examination of the fluid carried out later in the day.

In a few instances examination for the presence of the substance which reduced Fehling's Solution was postponed for a day or two - in one case for three days. Pending examination, it was either kept in an ice chest or left in the laboratory. It was always kept in a sterilised tube closed with aseptic wool.

The examination was delayed in order to test the truth of Naurotski’s observation that this
reducing substance was only present in freshly drawn specimens. My observations do not confirm this. In no case examined was the reducing substance found to be absent and it seemed to make no difference how long it was kept. This is of course only true so far as my observations go - for three days - a period sufficiently long to negative Naurotski's contention.

The Examination of the Tests.

In order to fully appreciate the slightest change in the tests, it was found useful to examine them by reflected light in a specially constructed box. This box was square and was made of blackened tin with a small lateral opening large enough to admit a stand holding six tubes. The interior was illuminated by an incandescent burner, which was suspended from the roof. The tubes were put inside and viewed against the light and the dark background.

The advantages of this are apparent. The slightest turbidity is at once seen, in comparing the tests variations in intensity are easily appreciated, and the standard of light is always the same. Moreover - since artificial light is used - an examination can be carried out at night.
DESCRIPTION OF WORK DONE.

A Table has been printed showing the amount of work done and the results obtained.

In all, 225 cases have been examined. Of these, 50 are cases of general paralysis, while the remaining 175 are drawn from other types of insanity. From a general glance at the Table it will be noticed that it was only in the paralytic cases consisting of general paralysis, tabes dorsalis and cerebro-syphilis that a lymphocytosis was obtained. In other words, all the non-paralytic cases had a count below 1.5 per cmm.

Turning to the proteid tests, one will see that the same (a positive reaction) holds good with the one exception - an epileptic who had a positive Ross Jones and Noguchi.

This would tend to support the contention that, as regards insanity, the presence of a lymphocytosis with positive proteid reactions indicates a paralytic psychosis of, in all probability, a specific origin.

It is necessary to consider separately the types of insanity examined.
I. General Paralysis - 50 Cases.

The 50 cases examined were all clinically definite general paralytics.

A lymphocytosis - varying from 4 to 200 per cmm. - was present in them all.

Two cases only were partial to the Ross Jones and Noguchi tests. These two cases were of long standing, and might well be considered as being practically stationary. They were not examined by the other three tests.

There appears to be no connection between the amount of the lymphocyte count and the stage of the disease. Some early cases that were examined gave a marked lymphocytosis, while in more advanced cases - even in the third stage - it was comparatively small.

The same holds good, to a less degree, in connection with the qualitative test for proteid. An early case as a rule does not give a partial reaction, whereas - as has been noticed above - an old and chronic general paralytic may. This does not apply to cases in the third stage, who usually have a marked positive reaction, but simply to those chronic cases who drag on, month after month, without apparently getting much worse. They are chronic cases in whom the disease is practically stationary.
Considering the amount of albumen as registered by the albuminimeter, I could find no relation between it and the lymphocytosis. A large lymphocyte count occurred in cases where the amount of albumen was considerable, and also in cases where it was comparatively small. On the other hand, a large amount of albumen was found with a small lymphocytosis.

Consequently it is impossible to judge of the stage of the disease from the amount of the count or the quantity of albumen, and, as these are so independent of each other in regard to their intensity of reaction, no information can be obtained by studying their relations.

It will be noticed that the quantity of albumen is very much increased in these cases, and, with the exception of the case of tabes dorsalis which is a similar disease, there is not one single case of those examined where the quantity of albumen is sufficiently large to constitute a positive reaction.

II. Tabes Dorsalis - 1 Case.

This was a very advanced case. No definite history of syphilis could be obtained, but there were circumstances connected with the case which made one strongly suspect that infection had occurred.
III. Cerebral Syphilis - 1 Case.

In this case a definite history of syphilis was obtained. The clinical symptoms pointed to the presence of a cerebral tumour, which was almost certainly of a gummatous nature.

In connection with this case it is a noticeable fact that whereas the Ross Jones, Nonne and Apelt and Alcoholic tests were only partial, the Noguchi and Carbolic were fully positive. This will be referred to again later.

IV. Dementia - 18 Cases.

Many of these cases were suffering from dementia secondary to some other type of insanity. The three partials were cases of senile dementia of a very profound nature and who had at the same time well marked arterio-sclerosis.

V. Dementia Praecox - 23 Cases.

In this group there are five partials.

Of these, two showed profound dementia of some duration, while the other three were cases exhibiting well marked Katatonia.

Judging from the severity of the symptoms, I do not think there can be much doubt that in these
cases degenerative changes had occurred in the brain cells.

VI. Delirious Insanity - 30 Cases.

This is one of the most interesting groups examined, since the results obtained lead one to believe that prolonged excitement can be responsible for the presence of globulin, and moreover that this globulin tends to disappear when the patient becomes convalescent. There were six cases who gave a partial proteid reaction, and they were all acute cases who had been excited for some time. On admission, though restless, their fluids were found to be normal. After about six weeks of continued excitement they were again lumbar punctured, and the partial reaction was obtained.

For a third time their fluid was examined - on this occasion during convalescence - and was found to be normal.

I do not think there can be any degenerative changes in these cases since two of them have been discharged recovered and the other four are quite convalescent.

VII. Delusional Insanity - 10 Cases.

Two of these cases gave a partial reaction to
the proteid tests. They were both cases of well marked paranoia, with a certain amount of dementia.

VIII. Epileptic Insanity - 13 Cases.

This group furnishes some interesting results. There is one case giving a positive reaction to the Ross Jones and Noguchi tests, the only case among the non-paralytic cases examined.

At the time this reaction was obtained, the patient was very excited and was having a great many fits during the night and also during the day. There was no history of syphilis, and his Wassermann reaction was negative. Consequently a specific taint inherited or otherwise could not be entertained as either causing or aiding the production of this positive reaction.

After nine months he was again lumbar punctured and his fluid was quite negative to all the proteid tests. At this time he was having very few fits, was very well mentally and was working in the garden.

In six other cases, the reaction was partial. In four of these there was present much excitement and fits were frequent. The other two were taken from patients during Status Epilepticus. Their fluids had been examined before the attacks and had been found to be negative.
The pressure of the fluid was not increased during the Status Epilepticus.

Both these cases died from exhaustion in spite of everything that was done to stop the fits.

A third case, whose attack was not so severe and who recovered, gave a negative reaction.

IX. Congenital Imbeciles - 11 Cases.

Three of these cases gave a partial reaction. The degree of imbecility was no greater in them than in some of the others who gave a negative reaction, but they were always in a state of more or less noisy excitement.

X. Manias - 34 Cases.

Nine of these gave a partial reaction. In every one of these the patient was excited and restless at the time of examination. A few of them were cases of recurrent mania of long standing, and showed a certain amount of dementia. Two of these partials were examined again when they had been some time quiet, and the reaction proved negative.

XI. Melancholia - 34 Cases.

Four of these gave a partial reaction. They
TABLE showing an Examination of 50 Cases of General Paralysis and 175 Cases of other Psychoses for Lymphocytosis, Qualitative and Quantitative Proteid Tests, and the Reduction of Fehling's Solution.

<table>
<thead>
<tr>
<th>TYPES OF INSANITY</th>
<th>Number of Cases</th>
<th>Lymphocytosis</th>
<th>Qualitative Test. Rose-Jones</th>
<th>Qualitative Test. Noguchi</th>
<th>Qualitative Test. Nonne-Apelt.</th>
<th>Qualitative Test. Alcohol, 80%</th>
<th>Qualitative Test. Carbolic, 4%</th>
<th>Quantitative Test. Albrecht's Albuminimeter</th>
<th>Reduction of Fehling's Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. PARALYTIC CASES</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. General Paralysis</td>
<td>50 50</td>
<td>50 48 2</td>
<td>50 48 2</td>
<td>35 35</td>
<td>35 35</td>
<td>35 35</td>
<td>35 35</td>
<td>35 29</td>
<td>50 50</td>
</tr>
<tr>
<td>II. Tabes Dorsalis</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
</tr>
<tr>
<td>III. Cerebral Syphilis</td>
<td>1 1</td>
<td>1 1</td>
<td>1 1</td>
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<td>1 1</td>
<td>1 1</td>
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<td>1 1</td>
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<tr>
<td>B. NON-PARALYTIC CASES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV. Dementia</td>
<td>18 18</td>
<td>18 3 15</td>
<td>18 3 15</td>
<td>7 7</td>
<td>7 7</td>
<td>7 7</td>
<td>7 7</td>
<td>15 2</td>
<td>14 14</td>
</tr>
<tr>
<td>V. Dementia Praecox</td>
<td>23 23</td>
<td>23 5 18</td>
<td>23 5 18</td>
<td>11 2 9</td>
<td>11 2 9</td>
<td>11 2 9</td>
<td>11 2 9</td>
<td>23 3</td>
<td>23 23</td>
</tr>
<tr>
<td>VI. Delirious Insanity</td>
<td>30 30</td>
<td>30 6 24</td>
<td>30 6 24</td>
<td>16 2 14</td>
<td>16 2 14</td>
<td>16 2 14</td>
<td>16 2 14</td>
<td>28 8</td>
<td>30 30</td>
</tr>
<tr>
<td>VII. Delusional Insanity</td>
<td>10 10</td>
<td>10 2 8</td>
<td>10 2 8</td>
<td>10 2 8</td>
<td>10 2 8</td>
<td>10 2 8</td>
<td>10 2 8</td>
<td>9 2</td>
<td>9 9</td>
</tr>
<tr>
<td>VIII. Epileptic Insanity</td>
<td>13 13</td>
<td>13 6 6</td>
<td>13 6 6</td>
<td>5 4 1</td>
<td>5 4 1</td>
<td>5 4 1</td>
<td>5 4 1</td>
<td>12 0</td>
<td>13 13</td>
</tr>
<tr>
<td>IX. Congenital Imbeciles</td>
<td>11 11</td>
<td>11 3 8</td>
<td>11 3 8</td>
<td>6 2 4</td>
<td>6 2 4</td>
<td>6 2 4</td>
<td>6 2 4</td>
<td>11 1</td>
<td>11 11</td>
</tr>
<tr>
<td>X. Manias</td>
<td>34 34</td>
<td>34 9 25</td>
<td>34 9 25</td>
<td>19 4 15</td>
<td>19 4 15</td>
<td>19 4 15</td>
<td>19 4 15</td>
<td>33 5</td>
<td>34 34</td>
</tr>
<tr>
<td>XI. Melancholiais</td>
<td>34 34</td>
<td>34 4 30</td>
<td>34 4 30</td>
<td>24 3 21</td>
<td>24 3 21</td>
<td>24 3 21</td>
<td>24 3 21</td>
<td>32 5</td>
<td>33 33</td>
</tr>
<tr>
<td>TOTAL</td>
<td>225 52</td>
<td>173 41 134</td>
<td>225 51 134</td>
<td>135 36 20 79</td>
<td>135 36 20 79</td>
<td>135 36 20 79</td>
<td>135 37 19 79</td>
<td>199 30</td>
<td>131 219</td>
</tr>
</tbody>
</table>

Note: Number of cases may not add up due to rounding or partial data.
were all cases of well marked melancholia, with a considerable amount of restlessness.

THE COMPARATIVE VALUE OF THE QUALITATIVE REACTIONS.

One's object in employing so many tests - any one of which could be relied upon to demonstrate the presence of excess of globulin - was to form an opinion as to their relative value. This was easily done by comparing the intensity of their reactions to the same fluid. When placed side by side in a stand and viewed in the special chamber, any disparity could at once be detected.

It was found that the Noguchi test and also the Carbolic test were too sensitive. A quantity of globulin sufficient to cause a moderate reaction with the other tests would register a fully positive Noguchi and Carbolic. The example of this is seen in the case of cerebral syphilis (see above). Here the Noguchi and Carbolic tests are fully positive, while the other three are only partial. Hence - if using these tests alone - one might be led to form a wrong opinion regarding the case under examination.
Another disadvantage dependent upon the over sensitiveness of these tests is apparent when dealing with a specimen which contains a trace of blood. No change will probably be observed in the three other tests, whereas the Noguchi and Carbolic will register a partial or fully positive reaction. This again might easily mislead the examiner, especially if he should be unaware that the specimen contained blood.

The faintest trace of blood can be detected at the bottom of the tube after the fluid has been centrifuged. It is therefore of the greatest importance that one should look for the presence of blood before proceeding to carry out the qualitative tests.

The Ross & Jones Test.

This test is very easy to perform and is probably the most useful test of the five. No accurate measurement of quantities is required, and as the reaction depends simply on the formation of a sharp distinct ring at the junction of the fluids, the result is easily seen.

The Nonne Apelt Test.

This is - like the Ross Jones test - an Ammonium Sulphate reaction. It has, however, two distinct
disadvantages. Firstly, to be successfully performed, accurate measurement of quantities is absolutely necessary. Secondly, the reaction depends, not on a distinct ring, but on a general turbidity and opalescence, whose intensity it requires some experience to interpret. It is often a matter of some difficulty, especially when one is new to the test, to know exactly how much significance one can attach to the amount of reaction present.

**The Alcohol Test.**

This test has exactly the same disadvantages as the Nonne and Apelt test.

**The Noguchi.**

This test has the great disadvantage of being performed in two stages. In both these stages, boiling is required. Moreover, the test must be done without any pause, and accurate measurement of quantities is most essential. Consequently the test requires more careful and accurate manipulation than the others, and also takes up much more time.

These disadvantages, added to the fact that it is undoubtedly too sensitive, greatly diminishes its value as a differential test.
Carbolic Test.

This has the advantage of being more easily performed. It is, however, much too sensitive and consequently cannot always be relied upon.

THE QUANTITATIVE TEST FOR PROTEID.

Aufrecht's Albuminimeter.

It will be noticed that the negative column is marked "below 0.075%". This is done because one never gets a specimen entirely free from proteid owing to the quantity of globulin normally present. An amount of 0.075% and above is considered partial, while 0.1% and above constitutes a positive reaction.

The percentages of the partial and positive reactions are made low so that a small increase will be at once appreciated. It must be remembered that one is dealing with small quantities.

One would naturally expect that the results obtained by the Albuminimeter would tally with those obtained by the qualitative tests. Thus when a large quantity of albumen was found, one would look for positive qualitative reactions. On the other hand, in cases having little albumen, one would expect the tests to be negative.
This, however, is not always the case, and the exceptions to this natural conclusion are to be found among the paralytic and the non-paralytic cases.

Among the paralytic cases — where the proteid was much increased — there are six partials in the quantitative column. Turning to the qualitative column, one finds that only two of these six are partial, the other four being fully positive.

Among the non-paralytic cases, the examples were much more striking and have been placed in a special table. Here one is dealing only with partial and negative cases, since no single case among the non-paralytic insanities had sufficient albumen to constitute a positive reaction.

There were 163 cases of non-paralytic insanity examined by the Albuminimeter. Of these, 32 gave a partial reaction and 131 a negative.

The 32 were examined by the qualitative tests with the following results:

(a) 1 Case — Positive = 3.1%
(b) 24 Cases — Partial = 75. %
(c) 7 Cases — Negative = 21.8%

(a) It seems that a positive reaction to the qualitative tests does not necessarily mean a positive quantitative reaction. This has already been
noticed in connection with the paralytic cases and will be referred to later.

(c) Here 7 cases - that have undoubtedly an abnormal quantity of albumen present - have no abnormal quantity of globulin.

The 131 negatives were also examined by the qualitative tests and gave the following results:

(al) 17 Cases - Partial = 12.9%
    114 Cases - Negative = 87.0%

Thus with no increase of albumen, 17 cases showed the presence of globulin to an abnormal degree.

It would therefore appear as if there were two kinds of albumen present in the cerebro-spinal fluid in insanity and that these two could be increased in amount irrespective of each other. One of these is certainly globulin - known to be a normal constituent of the fluid. The other is probably albumen, believed to be an abnormal constituent of the fluid.

One knows the class of disease (paralytic insanities) in which both kinds of albumen are present to excess, giving one definite signs of such excess
TABLE showing an Analytical Comparison of the Quantitative and Qualitative Albumen Columns in Non-Paralytic Cases.

<table>
<thead>
<tr>
<th>QUANTITATIVE ALBUMEN REACTION</th>
<th>QUALITATIVE ALBUMEN REACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POSITIVE</td>
</tr>
<tr>
<td></td>
<td>Number of Cases.</td>
</tr>
<tr>
<td>Partial, 32 cases</td>
<td>1</td>
</tr>
<tr>
<td>Negative, 131 cases</td>
<td>—</td>
</tr>
</tbody>
</table>
in both the qualitative and quantitative columns.

We can also understand an increase in the quantity of globulin without the presence of albumen (αI) since the deviation from the normal is not great.

Prolonged excitement or frequent fits in epileptics might be responsible for this.

But one cannot account for the presence of albumen - an abnormal constituent - without any change in the quantity of globulin. One has yet to learn the circumstances that bring this about, and it is a subject that needs further investigation.
SUMMARY.

1. The Presence of a Lymphocytosis.

A lymphocytosis was present in 100% of the paralytic cases examined. This would justify one in regarding it as a valuable diagnostic sign in general paralysis and cerebral syphilis.

Since it was absent in all the non-paralytic cases, its occurrence in Asylum practice would appear to be limited to cases of paralytic insanity.

2. Qualitative Proteid Reaction.

Although an excess of globulin was found to be present most consistently in the paralytic cases, it was also found among the non-paralytics. Consequently its presence in excess cannot be looked upon as a certain indication of general paralysis or cerebral syphilis, or indeed of a specific taint.

The greater percentage of the non-paralytic cases giving a partial reaction were cases who had been very excited for a prolonged period. The excess of globulin disappeared during the convalescence of these patients.

A smaller percentage were cases showing well-marked degenerative changes. In these the changes
were of course permanent and the globulin was always present.

This excess of globulin would appear to be due to metabolic changes dependent upon either great and prolonged cerebral activity or degenerative changes in the brain cells.

Tests.

The Ross and Jones is undoubtedly the best reaction. It is easily performed and is easily read and at the same time is not too sensitive.

3. Quantitative Examination.

The amount of albumen as registered by the albuminimeter is far greater in the paralytic cases than in the non-paralytic cases - in fact there is no positive reaction in the quantitative column among the non-paralytics. It would therefore appear that any case in whom the albumen reached 1% or over would belong to the paralytic group. Hence this may be considered a valuable diagnostic sign of general paralysis or cerebral syphilis.

It has been seen that a case may be positive to the tests and not positive to the albuminimeter, and consequently if relying upon the tests alone, one
might easily be led wrong. If, however, one finds a positive test with a positive result in the quantitative estimation, one's position as regards diagnosis is far more secure.

4. The Reducing Substance to Fehling.

This is generally believed to be glucose. It was found to be present in every case examined and did not disappear when the fluid was kept.
CONCLUSION.

To make a thoroughly satisfactory examination of the cerebro-spinal fluid, I have come to the conclusion that one should use three methods:

(a) Lymphocyte Count  
(b) The Ross Jones Globulin Test  
(c) Aufrecht's Albuminimeter.

By employing a combination of these three, I think there can be no doubt that the diagnosis arrived at - whether positive or negative - will be the correct one.

The clinical symptoms can only be regarded as useful in raising one's suspicions. On occasions they definitely lead one wrong. I have seen a case come into the Asylum with affected gait, slurring speech, sluggish pupils, unequal and irregular, tremors of tongue and hands and exaggerated knee jerks and be diagnosed as a general paralytic at once. A subsequent examination of his fluid proved this diagnosis to be incorrect. This is of course rare, but still it is an unpleasant possibility which should always be kept in mind. An alcoholic case, especially, may have all the clinical symptoms of general paralysis and may strike one as being a
typical case of this disease. After a few weeks these symptoms will gradually disappear and the patient will recover, leaving one the wiser by one's mistake.

Also it must be remembered that the symptoms of general paralysis may simulate those of other insanities - the patient may be much depressed or he may be considered a typical Dementia Praecox, or a case of acute or subacute delirious insanity. There again mistakes are apt to occur.

The most important reason, however, for the early diagnosis of general paralysis is the question of treatment. As it is, by the time the case comes into the Asylum the disease has made distinct progress. If then more time is allowed to elapse before the diagnosis is made certain, the patient is considerably damaged mentally and his physical resistance much lowered before any special treatment is commenced. Hence the results are neither beneficial to the patient nor flattering to the treatment.

If, however, the disease is recognised early, the patient is at once put under the most healthy conditions possible and his strength conserved. Thus he is in the best possible position for the trial of any special treatment (such as Dr Ford
Robertson's serum or "606") whose value can then be fairly tested.

In the light of these facts I would strongly advocate the routine examination of the cerebrospinal fluid in every new admission. An examination - such as I have indicated - is easily carried out and could be performed by the Medical Officer of any Asylum.

If this were done, mistakes in the diagnosis of General Paralysis would not occur, and the cases would have every advantage in the way of treatment.
BIBLIOGRAPHY.


2. MAJENDIE: "Recherches sur le liquide céphalo-rachidien", 1825.

3. BERNARD: Quoted by Dirksen (see above).


5. C. SCHMIDT: Quoted in Hoppe-Seyler.


11. QUINCKE: Kongress fur Innere Medicin, Wiesbaden, 1891.


24. **SICARD:** "Le Liquide Cephalo-rachidien." 1902.

25. **SIEMERLING:** Neurol. centralbl. 1904. S.484.


28. **GUMPRECHT:** "Die technik der speziellen therapie." 1900, S.262.


31. **AGER:** Medical Annual. 1908, p.503.

31a. **MOTT:** Lancet, July 9, 1910.
32. Quoted by Matthieu - "Les Fonctions Rachidiennes accidentelles." Monographies Cliniques. 1902, No.29.


44. AUFRECHT: Deutsche Medecin Wochenschrift. No.46, 1909.


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