of the war, and as it may involve a recasting of current views on the subject of convulsive disorders it merits a brief consideration. One encounters cases, for instance, in which the attacks started abruptly, are severe and recurrent, and have been repeatedly certified by competent observers as true epilepsy. Yet investigation yields neither individual nor family history of epilepsy or allied neuroses, and though the attacks may be frequent and severe, there is no sign of mental degeneration, and most notable of all, they tend spontaneously to disappear. Indeed, excluding the cases of classical epilepsy in which there is almost invariably an antecedent history of fits associated with mental hebetude and confusion, if not actual dementia, as well as physical stigmata, it appears to be generally true of the fits which occur as a result of the war that they tend to diminish in severity and ultimately to cease.

May one conclude that there exist affections clinically indistinguishable or difficult to distinguish from idiopathic epilepsy, which are psychogenic in origin and which are amenable to psychic influences, in that, given a suitable *milieu*, they tend to spontaneous recovery.

In the study of mental mechanisms just outlined I have endeavoured, however inadequately, to establish a logical relationship between the minor departures from mental health, and their culminating manifestations in an actual psychosis. The fact that happily in many cases the process is arrested at this early or prodromal stage in no way contravenes, of course, my general thesis. Finally it is frankly admitted that such analysis as has been here employed is neither profound nor exhaustive, but as my main aim has been to demonstrate a prospective rather than a retrospective continuity in the ideational processes involved, it has seemed sufficient for the purpose.

Pressure Changes in the Cerebrospinal Fluid.[1] By D. O. Riddel and R. M. Stewart, M.D.Edin.

During the course of the last few years the study of the cerebrospinal fluid in both mental and nervous disorders has made rapid progress, and with the introduction of methods of precision much useful knowledge in regard to its physical, chemical, and serological properties has been acquired. Nevertheless, much remains to be learnt, and we propose to submit observations on one aspect of the subject which is still in its infancy, namely, the pressure of the cerebrospinal fluid, and the modifications which it may undergo in the insane.

[1] A paper read at a meeting of the Midland and Northern Division held at Stafford in October, 1923.

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At the outset, however, it will be convenient to refer in as few words as possible to the distribution and circulation of this fluid.

The cerebrospinal fluid is contained in the ventricles of the brain, and also fills the subarachnoid spaces. Its total volume averages about 150 c.c., and this amount is sufficient to form an efficient fluid cushion for the central nervous system. At the base of the brain the space between the arachnoid membrane and pia mater is widened to form the various cisterns, and in the spinal subarachnoid space there is also a relatively large collection of fluid. On the other hand, upon the surface of the cerebral hemispheres the subarachnoid space is very restricted, and here the confined fluid is present only as a capillary layer. Although there is no single conclusive piece of evidence, the data derived from histological, pharmacological and pathological investigation point strongly to the choroid plexuses as the chief source of the cerebrospinal fluid. Whether or not it is a true secretion or a dialysate has not yet been definitely settled. The stream of cerebrospinal fluid, starting within the ventricles, makes its way through the foramina of Monro into the third ventricle, and thence through the aqueduct of Sylvius into the fourth ventricle. From the latter situation it is said to escape through the foramen of Majendie and those of Luschka into the subarachnoid space. What happens to the fluid after it reaches the cisterna magna is somewhat doubtful, but it is generally assumed to pass upwards over the cerebral hemispheres and downwards into the spinal subarachnoid space. Placed in relation to the former situation are its chief avenues of escape, for it has been recently shown by Weed that the Pacchionian bodies which are so often seen in the brains of the insane are really pathological transformations of numerous microscopic arachnoid villi, whose function it is to filter the cerebrospinal fluid in its passage through them into the large intracranial venous sinuses. In the spinal subarachnoid system the amount of absorption must be very small, for in this locality, since there are neither dural sinuses nor arachnoid villi, the lymph channels in relation to the spinal nerve roots provide the only possible outlet for the fluid. It is also necessary to state that certain authorities hold that the cerebrospinal fluid bears a much more intimate relation to the nervous system than that which we have outlined above. It is believed by many that the fluid extends along the whole length of the adventitial sheaths of the cerebral vessels to reach finally the spaces surrounding the nerve-cells, and Monakow goes even further, for he believes that the brain is nourished by a direct passage of fluid through the walls of the ventricles into the brain substance itself. It will be obvious that if this intimate relationship of cerebrospinal fluid to brain tissue exists, abnormalities of cerebrospinal fluid pressure are bound to affect the

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functions of the brain, and may perhaps be responsible for " pressure " headaches, and even mental derangement. Before, however, considering the experimental data bearing on this point, certain clinical considerations demand attention.

Access to the cerebrospinal fluid may be gained either by making a puncture somewhere in the region of the lumbar subarachnoid space, or by introducing a needle into the cisterna magna at the base of the skull. The pressure of the fluid may then be measured in two ways: roughly, by noting the manner in which the fluid escapes —whether drop by drop, or in a stream—or more accurately, by attaching a manometer to the lumbar puncture needle before it is introduced. The former method is one which cannot be recommended, since so many fallacies are introduced, and we state unhesitatingly that the manometric method is the only one on which reliance can be placed. Whichever method be employed, it is of the first importance to record the exact posture of the patient when the operation is performed, for with the subject lying horizontal in the flexed position, the normal pressure will invariably be found to be less than when puncture is made with the patient in the usual sitting attitude. Furthermore, apart altogether from the general attitude and position of the patient's limbs, the pressure is influenced to a considerable degree by the attitude of the head—that is to say, by the degree of flexion or extension of the cervical spine. As Zylberlast Zand (1) has shown, flexion of the head on the thorax with the patient in the lying-down position always increases the pressure, whereas in the seated position flexion of the head provokes a lowering of pressure. The explanation of this phenomenon must be sought in the factors regulating cerebrospinal fluid pressure, which are probably three in number: (1) The elasticity of the meninges which resist dilatation by the fluid; (2) blood-pressure in the meningeal and cerebral vessels. (3) The hydrostatic factor, *i.e.*, the pressure exercised by a column of liquid on any given point. The last factor is purely physical, while the first two are biological. For the purpose of expressing in concrete terms the part played by each of these three factors, Pfaundler (2) measured the cerebrospinal fluid pressure when puncture was made—(*a*) with the patient seated, that is to say, when all three factors were in action; (*b*) in the recumbent position, when the hydrostatic factor is excluded; and (*c*) in the cadaver, when the elasticity of the meninges is the sole factor. His figures show that the hydrostatic factor constitutes 24 *per cent.* of the total pressure; the blood-pressure factor 68 *per cent.*, and the elasticity of the meninges 8 *per cent.* When the patient is in the recumbent posture we are dealing only with elasticity and blood-pressure, and as the former plays a minimal *rôle*, the blood-pressure in the vessels of the

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nervous system must have most to do with maintaining the cerebrospinal fluid tension. In this attitude the normal pressure lies in the neighbourhood of 100 to 150 mm. of water, but where meningeal disease exists the pressure may be 200 mm. or more, and these readings may be increased to 400 or over by raising the patient to a sitting posture. Hence the importance of recording the attitude of the patient as well as the actual reading obtained with the manometer. With regard to the curious differences in pressure obtained by altering the position of the patient when the head is flexed, the explanation is to be found in the factors mentioned above, for when the patient is lying down with the neck flexed, the cervical vessels are compressed so that a venous stasis is created within the cranium, and hence the pressure rises. When the patient is seated the whole vertebral column is flexed, and in this attitude not only is pressure on the veins of the neck avoided, but the elevated position of the head itself favours venous return, and hence the pressure of the cerebrospinal fluid is actually lowered.

Lastly, it is important to recognize that a factitious increase of intrathecal pressure may be obtained if readings are taken immediately after lumbar puncture has been performed, and judging by reports in the literature, this mistake is constantly being made. Since any alteration in the intracranial venous pressure effects changes in the cerebrospinal fluid in the same direction, in violent or excited patients the readings are always high, for vigorous movements of the body together with forced respiration raise the intracranial blood-pressure, and inevitably that of the spinal fluid as well. Even if the patient remains quiet during the performance of the operation, the pain evoked by piercing the skin is sufficient in itself, save in the comatose state, to cause an immediate rise of pressure. We have never failed to obtain this effect in several of our observations. Thus in one case the cerebrospinal fluid pressure after puncture rose to 520 mm. water, and almost immediately afterwards fell to 155 mm. In another instance the initial reading of 290 was followed after three minutes by a fall to 170 mm., at which level the pressure thereafter remained constant.

Bearing these pitfalls in mind, we may briefly summarize our observations on patients suffering from mental disease as follows:

In healthy imbeciles the cerebrospinal fluid pressure lies within normal limits—that is, from 100–150 mm. H_2O. In katatonic dementia præcox the pressure lies between 170 and 180 mm. In idiocy with gross brain disease the pressure is considerably above normal—up to 250 mm. In all cases of early and well-developed general paralysis hypertension is invariably found; usually the pressure is in the neighbourhood of 300 mm., while in advanced bedridden

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cases the pressure is either normal or below normal. In cerebrospinal syphilis, in epilepsy and in insanity with gross brain disease a reading considerably above normal is almost always recorded. In the depressed phase of manic-depressive insanity no uniform results are obtained, but on the whole the pressure tends to be raised. We have no observation on cases of mania. All our observations were made with the patients lying down. In these cases presenting evidence of hypertension a very marked improvement could often be noted after the withdrawal of 10 or 15 c.c. of fluid, and this beneficial result was particularly striking in cases of general paralysis.

With regard to general paralysis the good effects obtained may, of course, be ascribed not only to the reduction of pressure, but to the removal of accumulated toxins in the cerebrospinal fluid. Cerebrospinal fluid drainage appears to be practised much more extensively in America than in this country, and there seems to be no question that general paralytics treated in this way become much more tractable, are less liable to seizures than the untreated case, and not infrequently improve to a remarkable extent.

This now brings us to the final section of our paper, namely, observations on spinal drainage without lumbar puncture, and for a proper grasp of this procedure it is essential to present a brief summary of the work of certain American physiologists. In the course of some experiments on cats undertaken to determine whether an increased amount of salt could be detected in the cerebrospinal fluid after intravenous injection of hypertonic solutions of sodium chloride, Weed and McKibben (3) observed that within a short time after intravenous injection cerebrospinal fluid could not be obtained when the subarachnoid space was entered. Further experiments in which a manometer was attached to the lumbar puncture needle showed that in the cat hypertonic salt solutions when given intravenously cause a marked fall, often below zero, in the cerebrospinal fluid pressure. The physiological explanation of this phenomenon appears to be concerned with changes in the osmotic value of the blood. Fluid is drawn rapidly into the blood-stream from all available sources, and this process continues until the osmotic pressure in the fluid cavities is reduced below that within the vessels. Thereafter the normal equilibrium is established by the replacement of these fluids from the blood. In the case of cerebrospinal fluid absorption is both rapid and vigorous, and reaches its height in from two to three hours after administration of the hypertonic solution.

Moreover, the marked changes of the cerebrospinal fluid have a definite relation to the resultant volume of the brain, intravenous injection of strong hypertonic solutions being associated with definite

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shrinkage, and the injection of hypotonic solutions with appreciable increase of the brain bulk. At a later date these results were confirmed by Foley and Putnam (4), who showed that it was also possible to effect similar changes by introducing the hypertonic solution into the gastro-intestinal tract. The clinical application of these experiments to man was first demonstrated by Haden (5), who obtained symptomatic improvement in cases of cerebrospinal meningitis by the intravenous injection of 40 *per cent.* glucose solution. Following this, Foley and Cushing (6), Sachs, and again Foley (7) recorded their experiences in cases exhibiting high grades of intracranial pressure, the results being on the whole satisfactory, especially in those cases associated with cerebrospinal fluid obstruction.

It is, of course, no new discovery that the withdrawal of cerebrospinal fluid has a definite field of clinical application, for simple drainage by lumbar puncture has for some years been employed in America as an adjunct to the salvarsan treatment of neuro-syphilis. Dercum (8), who is an enthusiastic advocate of spinal drainage, goes so far as to attribute the rather limited success of the Swift Ellis treatment entirely to the withdrawal of cerebrospinal fluid, which is an integral part of this procedure. Other writers, notably Gilpin and Early (9), believe that the penetration of arsenic can be increased by combining intraspinal injections with spinal drainage, a claim which has not been entirely borne out by subsequent work, for Mehrtens and McArthur (10) obtained no larger percentage of arsenic penetration when intravenous injections of salvarsan were followed by complete spinal drainage. In any case the amount of arsenic available for distribution in the diseased brain-tissue must be extraordinarily small, and further, it is by no means settled that arsenic penetrates the brain-tissues.

These considerations, however, have not deterred the advocates of intraspinal therapy, and the new method which we have outlined above has been enthusiastically adopted for increasing the amount of arsenic which may possibly be carried into the spinal fluid.

In the plan of treatment adopted by Corbus, O'Connor, Lincoln and Gardner (11), 100 c.c. of 15 *per cent.* hypertonic saline warmed to body temperature is given intravenously by the gravity method. At the end of six hours 0·9 grm. of neoarsphenamine is injected by the same route. This period of six hours between the two injections is chosen on the assumption that when the increased restorative formation was taking place a larger quantity than normal of arsenic would be carried into the subarachnoid space: 28 cases were subjected to this treatment, and on all but two arsenic was subsequently found in the spinal fluid. With regard to the therapeutic results, the authors content themselves with saying—"Some of the

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patients obtained their first negative serologic findings following this form of therapy." With five exceptions their cases were all examples of cerebrospinal syphilis which had been subjected to previous treatment, and it is therefore a little unfortunate that no comparison was made between the clinical results of the two forms of treatment.

In this connection the paper by Ebaugh (12) is much more satis-

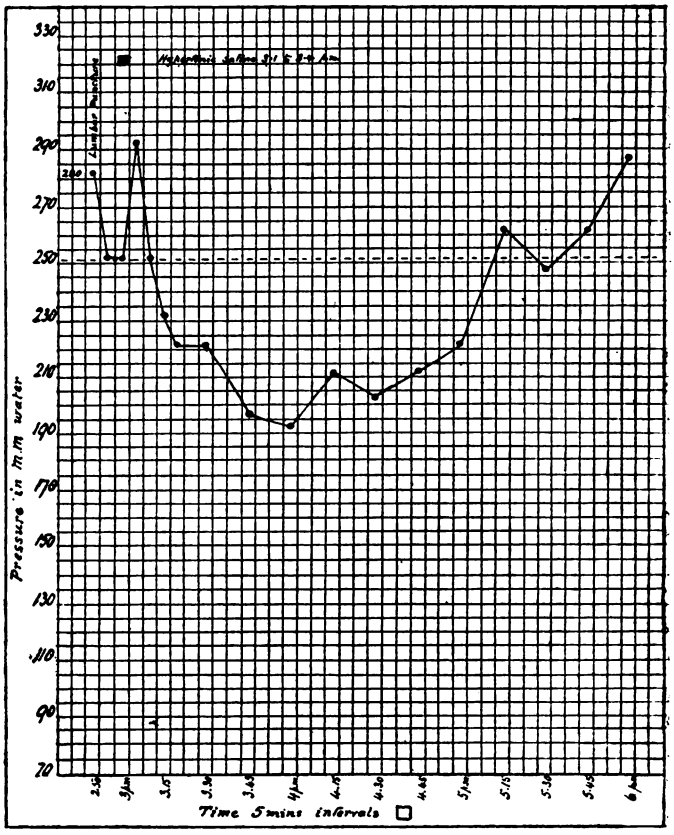


FIG. 1.—W. E—. General paralysis; early case.

fying. He states definitely that " no noteworthy changes were noted in the mental states of any patients with the exception of one case."

Our results with the ordinary methods of treatment for general paralysis have been distinguished for the most part by an entire lack of success, and we therefore decided to combine the Swift-Ellis treatment with intravenous administration of hypertonic salt solution. As a preliminary we considered it advisable to check the results of the various entries referred to above by observing the changes in

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cerebrospinal fluid pressure and the clinical progress, if any, effected by hypertonic solutions alone, and we believe our results are of sufficient interest to merit their description here.

In the plan of treatment adopted we started by performing lumbar puncture, care being taken to prevent the escape of any fluid. Before the puncture was made Eve's water manometer was attached

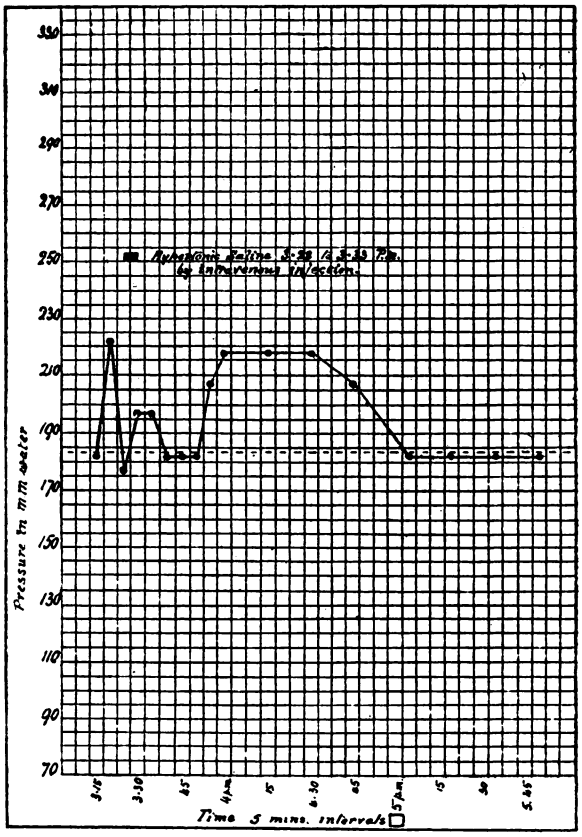


FIG. 2.—J. G—. General paralysis; advanced case.

to the needle, and readings of the intrathecal pressure were taken every two to five minutes, until it remained more or less constant. We then gave by the gravity method an intravenous injection of 50 c.c. of 30 *per cent.* sterile salt solution. Immediately following the injection the patient experienced a feeling of warmth, which slowly passed down the back until it reached the lumbar region. This sensation was in most cases followed by a short rigor, after which the patient recovered his equanimity. The charts which we present

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illustrate in detail the results of three observations on patients suffering from general paralysis. In Fig. 1 it will be seen that the spinal fluid pressure of an early example of general paralysis was reduced from 250 mm. to 190 mm. H_2O, and that the initial pressure was not restored until a period of nearly three hours had elapsed. Figs. 2 and 3 illustrate the results obtained in two advanced cases. In one of these the pressure underwent no diminution after the

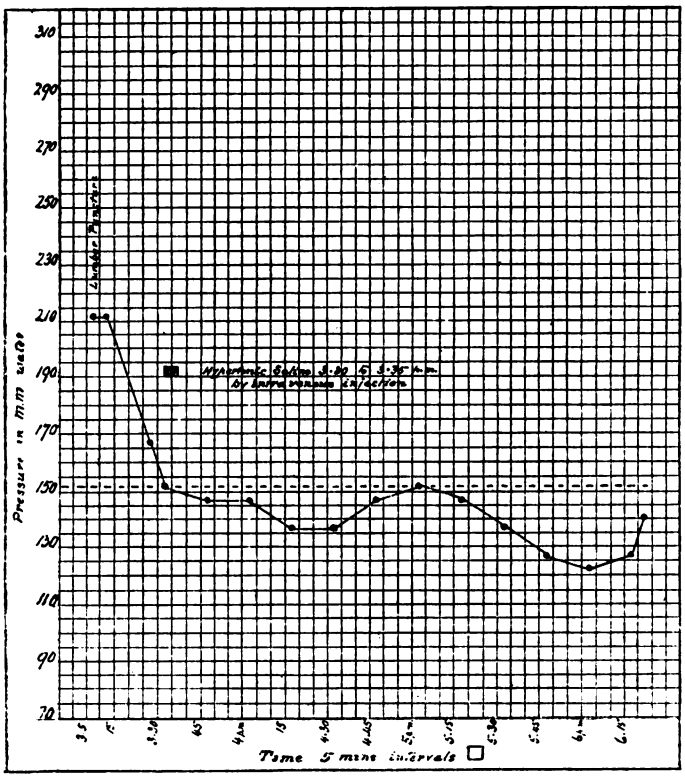


FIG. 3.—W. D—. General paralysis; advanced case.

administration of hypertonic saline, and in the other the fall was of a slight and transitory character.

Summary.—In the human subject the intravenous injection of 30 *per cent.* saline solution may condition a transient rise of cerebrospinal fluid pressure, quickly followed by a fall of pressure which persists for a considerable period. In patients suffering from early general paralysis similar results may also be obtained, but when the disease is fully established, hypertonic saline causes either a slight fall of pressure, persisting for a short period, or no appreciable altera-

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tion. In advanced cases of general paralysis attempts to increase the penetration of arsenic by this method of treatment seem foredoomed to failure, probably because the inflammatory reaction in the cortex and membranes of the brain impedes to a great extent the rapid absorption of cerebrospinal fluid.

In conclusion we would like to remark that the work of Weed would appear to place on a still firmer scientific basis the time-honoured custom of giving the insane patient a weekly dose of salts, since it now emerges that not only is his loaded colon relieved, but the condition of increased cerebrospinal fluid pressure as well, which we have shown to be not infrequently present.

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Twenty-eight Years' Lunacy Experience in Egypt (1895–1923).

By John Warnock, *C.M.G.*, M.D., B.Sc.Edin., Late Director of the Lunacy Division, Ministry of Interior, Egypt, and Director of Abbâsîya Hospital for the Insane, Cairo.

PART I.

Preliminary.

Having been honoured by requests to describe my experiences in Lunacy in Egypt, and my services in Egypt having recently come to a close, I desire on the present occasion to offer to my fellow-workers in England a *résumé* of the changes in Egyptian Lunacy administration for which I have been responsible during the past 28½ years.

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