that the vessels were blocked by what he terms "white thrombi"—i.e., colourless blood-corpuscles. He affirmed that the alteration began by a granular change in the endothelial walls of the capillaries, so that the characteristic white lines did not appear on treatment with nitrate of silver. On these granular places white blood-corpuscles were deposited and became so firmly fixed that even a strong injection would not drive them away. New homogeneous deposits were gradually formed over these cells, the whole obstructing mass soon undergoing a fatty degeneration. Now I am not disputing these conclusions in the main, for it is evident that a granular state of the capillaries ensues, and it is likewise true that leucocytes are frequently found in the vessels at points where they are breaking down; but it is too much to assert that this is the chief or only mode of obstruction of the capillaries, for they are often seen interrupted at points where only red corpuscles are to be found, and in particular I would draw attention to their being intercepted by endothelial nuclei in the manner described.

Glasgow.

THE RELIEF OF INTRA-CRANIAL PRESSURE BY THE WITHDRAWAL OF CEREBRO- SPINAL FLUID FROM THE BASAL SUBARACHNOID CAVITY.

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It is a well-recognised fact that in many affections of the brain the cerebro-spinal fluid is increased in quantity and that this is sometimes associated with increased intra-cranial pressure. The best known example is that of chronic hydrocephalus, in which disease the increased pressure leads to separation of the cranial bones and other symptoms. There is no doubt that in this instance the increased pressure is actually due to an excess of cerebro-spinal fluid, but it by no means follows that increase in the quantity of cerebro-spinal fluid is always associated with increased intra-cranial pressure, any more than that increased pressure is always associated with excess of the fluid in question. Briefly stated, the clinical conditions in which the cerebro-spinal fluid is increased in quantity are (a) meningitis, simple, epidemic or tuberculous, especially the last-named; (b) chronic hydrocephalus; (c) general paralysis of the insane and some cases of dementia; and (d) as a direct result of injury to the skull. Pathologically it is met with as a result of (a) meningeal inflammation, basal or cortical; (b) ventricular inflammation or ependymitis; (c) growths pressing on the veins of Galen; and (d) shrinking of the cortex from degenerative changes. Anatomically considered the fluid occupies the spaces between the pia mater and arachnoid, these being especially large at the base of the skull and beneath the cerebellum; a smaller amount is contained between the arachnoid and dura mater. Physiologically there is every reason to believe that the fluid is secreted by the ependyma of the ventricles and by the cells of the pia mater and arachnoid. The fluid appears to be constantly secreted and as constantly absorbed along the perivascular lymphatic vessels. In a case on which I operated some months ago, after removing a portion of dura mater from off the cortex, drops of cerebro-spinal fluid could be seen to collect on the dural aspect of the arachnoid and, running together, trickle down the surface of the brain to disappear beneath the cut edge of the dura mater, exactly like water collecting on the window of a railway carriage. That an increase in the amount of cerebro-spinal fluid is detrimental to life has been much discussed from time to time. When the fluid simply takes the place of shrunken convolutions and there is no coincident increase of pressure, as in many cases of dementia, it may fairly be argued that the increased amount can do no harm; but when the intra-cranial pressure is increased it is apparent that the excess of fluid can in no case be compensatory, for it would be equally rational to say that a pleuritic effusion compensates for a collapsed lung lying in an expanded chest, thus confusing cause and effect. As it is unlikely that the brain itself can swell so as to increase the pressure within the cranium (the question of

growths being neglected), it must be conceded that any increase of cerebro-spinal fluid coincident with an increase of intra-cranial pressure must be in the relation of cause and effect. As to the way in which the increase of fluid is brought about, it seems very probable that in irritative lesions the secretive cells are stimulated, over-secretion takes place and absorption by the lymphatics is interfered with. It is easy to imagine how dilated vessels can compress the lymphatic trunks which surround them and so further aid lymphatic obstruction. Perhaps the most frequent cause of increased intra-cranial pressure from over-secretion of cerebro-spinal fluid is tuberculous meningitis. The common condition post mortem is dilatation of all the ventricles, a rough or granular condition of the ependyma, increase of the cerebro-spinal fluid especially at the base of the brain, and more or less softening around the ventricles; in some cases the cortex is adherent to the surrounding pia mater. These cases were originally designated "acute hydrocephalus." It is a debatable point whether the softening is due to inflammation, transudation of fluid, or to the actual pressure exerted by the fluid; but for the purpose of my argument this is immaterial. My object is to show that removal of the excess of fluid by gradual drainage is of the highest importance in aiding the recovery, not only of patients suffering from meningitis of any kind, but also of those suffering from any of the diseases in which there is increased pressure from over-secretion of cerebro-spinal fluid. Taking the case of tuberculous meningitis again, it must be noted that there are usually three stages, known as "premonitory," "irritative," and "comatose," and from a study of the symptoms during these stages it is a fair conclusion that during the first two there is a gradual accumulation of fluid which leads to the comatose stage by a gradual increase of pressure on the various parts of the brain. There is a great similarity between the early diffuse symptoms of a cerebral tumour and those of tuberculous meningitis, and it seems only reasonable to infer that the gradual increase of pressure is the cause in each case, whilst the final stage of coma can only be explained on the supposition that the increased pressure leads to an annihilation of function by general compression. A sudden increase of intra-cranial pressure, as in cerebral hæmorrhage, leads to similar results. It is a matter for physiological experiment how much the intra-cranial pressure has to be increased in order to interfere with the circulation through the small cerebral veins and arteries, for this seems to be the way in which the symptoms are produced and is probably the cause of the softening around tumours and in cases of tuberculous meningitis. Arguing in this way, it seems only reasonable to conclude that removal of the excess of cerebro-spinal fluid in cases of tuberculous meningitis will relieve the symptoms and give the patients a greater chance of recovery by enabling them to battle with the tuberculous infection. The so-called natural drainage by the vertebral canal seems to be altogether inefficient. Reasoning from analogy, one would say that recovery from peritoneal or pleuritic tuberculosis, after removal of ascitic or pleuritic fluid, fully justifies the suggestion that a similar interference in cerebral tuberculosis may have a good result, with, however, the proviso that, inasmuch as the brain is a very much more delicate organ and much more likely to be damaged by pressure, the interference must be early—i.e., in the irritative stage. A similar argument holds good in meningitis from other causes and in cases of compression from over-secretion of cerebro-spinal fluid following injury. Concerning general paralysis of the insane, I can only refer to an excellent paper by Dr. T. Claye Shaw¹ and to one by Dr. J. Batty Tuke.² I have had no opportunity of carrying out their suggestions and can only say that their treatment seems perfectly justified by the results obtained.

Puncture of the brain for the relief of chronic hydrocephalus dates back to 1744, and since that time both aspiration and, later, continual drainage have been frequently performed with encouraging results whenever done antiseptically and as early in each case as possible. Various sites have been chosen for the operation of draining of the lateral ventricles, but in order to reach them it is necessary to go through a certain thickness of the cortex, a procedure which, though not dangerous, is not altogether desirable. It has been more recently suggested that the cerebro-spinal fluid should be drained by removing a couple of lumbar laminæ and opening the subdural space; this would certainly be a favourable place for drainage, but at the cost of weakening the

¹ Brit. Med. Jour., Sept. 12th, 1891.

² Ibid., Jan. 16th 1892

spine. The vertebral mode of drainage was adopted by me in the following case:—

CASE 1.—A boy aged five was admitted into the Victoria Hospital, Hull, on Aug. 10th, 1892, for a fluctuating swelling on each side of the dorso-lumbar spine; he was otherwise quite healthy. On the 12th the swelling was incised and a quantity of caseous matter was removed along with two carious spinous processes. The vertebral canal was not opened. The cavity was scraped and irrigated. On the 15th the patient was very sick for the first time, and the face was rather œdematous. The vomiting continued in spite of treatment until the 22nd, when the legs were noticed to be rather rigid, the knee-jerks increased and ankle-clonus was slight. On the 24th the right hand was "en griffe" and the arm muscles were rigid; the spastic condition of the legs was more marked; the right hand and legs could not then be moved voluntarily. The child was in a good deal of pain, semi-conscious, kept screaming out, and when he did so the legs became more rigid. There was very slight swelling over the sixth cervical laminae and tenderness on pressure all down the spine. The evening temperature was 100.2°. The wound being almost healed at this time, I decided to explore the upper part of the spine. On removing the fifth and sixth cervical laminae a collection of caseous matter was found beneath them pressing on the cord posteriorly. The spinal dura mater was very tense and without pulsation, so it was incised. A large quantity (four or five ounces) of clear fluid came away, and after its escape the cord pulsated freely. The opening in the dura mater was left open and the wound sewn up, a small drainage-tube being inserted. After the operation the child seemed much relieved; he only cried out occasionally, moved the affected arm, and was more conscious; the painful jerkings of the limbs were less marked. On the 25th the temperature, which before the operation was about 100° at night, rose to 103.8°. A considerable quantity of cerebro-spinal fluid had drained away. There were restless movements of the left hand and arm. The legs and the right arm were still contracted. Later in the day the left arm became rigid, Cheyne-Stokes respiration set in, and the patient died thirty-six hours after the operation.

Necropsy.—There was a caseating mass in the centre of the right lung; there were three large caseous masses in the cerebellum, one of which was in the vermiform lobe; the ventricles were dilated and the cortex was flattened. The spinal cord appeared healthy and there was no spinal meningitis. The condition of both wounds was quite satisfactory.

Though death was in this case inevitable, the child was greatly relieved by the operation; he had much less pain, the spasms of the limbs were less marked, and the right arm regained a certain amount of movement. The improvement seemed to be due to the relief of tension, which, however, was obviously in this case a palliative measure only.

The following is a case of what might be called "cortical drainage":—

CASE 2.—A boy aged ten was admitted into the Victoria Hospital on Sept. 13th, 1892, for fits. Four years previously to admission he had been struck on the forehead by a bottle; a serious scalp wound was the result, but no further history was obtainable. Two years ago he became strange in his manner and eighteen months ago he had his first fit. On admission the boy had a peculiar restless and excitable appearance. A scar about one inch long extended below the right frontal eminence. There was no paralysis nor were there focal symptoms of any kind. His parents said that he had a violent temper, told lies, stole and often talked ridiculous nonsense. They could not trust him to run errands and he was becoming a nuisance to everybody. All this was verified during his stay in the hospital. The fits began with a cry, there was no tonic stage, general convulsions came on, and recovery was complete in about three minutes. No aura could be made out; loss of consciousness was complete. There were no eye symptoms. At this time the boy had about three fits a day. Medical treatment with bromide of sodium was persevered with and electricity tried, but without result. He was discharged at the end of a month, no better, and attended at the out-patient department until Oct. 21st, when he was readmitted. The fits had increased in number up to five a day, and the moral condition was if anything more marked. On Nov. 23rd the site of the wound was explored and a circle of bone removed; the bone seemed thinner than one would have expected in that region. The dura mater bulged markedly and the finger pressed on it seemed to dip through a thick layer of fluid before coming on

to the brain, exactly like dipping on to the liver in a case of ascites. The dura mater was incised and about one ounce of clear fluid escaped. The brain looked greyish instead of pink, and the lymphatic vessels in the sulci were distended. The wound was sewn up and healed in a few days; there was no rise of temperature and convalescence was rapid. The fits increased in number to fourteen per diem until Nov. 17th, but became much shorter, so as to be merely transitory losses of consciousness. They then decreased in number until Nov. 26th, since which date and up to June 16th of this year he has not had one. His mental condition has improved very much indeed, and when last seen he was much more intelligent in appearance, was trustworthy, and as much pleased with his own improvement as his parents were. This case seemed to me at the operation to be undoubtedly one of meningeal cyst—i.e., a localised collection of cerebro-spinal fluid, the result of the injury. It is, perhaps, too early to say that the improvement is permanent, but the relief obtained cannot be doubted.

It is, however, particularly to the treatment of tuberculous meningitis that I wish to refer. The mortality at present is practically 100 per cent., for, though cases of recovery do occur, they are extremely infrequent for so common a disease. Unfortunately it often comes on as the closing point in a tuberculous career, but it does not follow that the primary cause is always or frequently a fatal condition. My attention was directed to the drainage of such cases by two papers by Mr. C. A. Morton,³ who shows how the fourth ventricle can be best reached post mortem. It is obvious that if the subcerebellar arachnoid space can be easily reached this would be the place above all others for drainage of the cerebro-spinal fluid, for there would be no track to make through the brain as in tapping the lateral ventricles, and there would be no subsequent want of stability in the spinal column as in drainage through the spinal membranes after laminectomy. The following case illustrates the method adopted by me in a child under my care.

CASE 3.—A child aged four and a half years was admitted into the Victoria Hospital on March 30th, 1893, for what was at first thought to be enteric fever. Subsequently a three weeks' history of ill-health and want of appetite was obtained. The child was quiet, took its food well and seemed in no pain. The spleen could be felt below the ribs. The temperature was about 101° at night and normal in the morning. A few râles could be heard in the chest. On April 4th the pulse was irregular and the patient drowsy. On the 8th the child was unconscious, with transient rigidity of the limbs, slight swelling of the optic discs, but good knee-jerks. On the 9th it had Cheyne-Stokes breathing; pulse 150; respiration 50. The patient was quite comatose, but moved occasionally and cried out as if in pain. Without giving chloroform I made a curved incision below the superior curved line of the occiput and to the right of the middle line. After reflecting the flap a circle of bone three-quarters of an inch in diameter was removed and the opening enlarged in a downward direction by Hoffman's forceps. The bone removed was very thin—nowhere more than one-sixteenth of an inch thick. The dura mater bulged very much and no pulsation could be felt. It was opened and a little fluid escaped. On passing a curved probe along the under-surface of the cerebellum and slightly raising it a very large quantity of clear cerebro-spinal fluid (about two or three ounces) gushed out; pressure was relieved, and the brain pulsation returned. The Cheyne-Stokes rhythm ceased, and the pulse became larger and regular, though still very quick. A very fine, almost capillary drainage-tube was inserted beneath the dura mater, and both it and the scalp wound were sewn up. There was nothing to show that the passage of a probe into very close relationship with the fourth ventricle had any injurious effect. For some time after the operation the condition of the child was satisfactory; the expression of the face was much more natural and the head was not moved as if the child was in pain. Eight hours later the breathing became more rapid, the Cheyne-Stokes rhythm returned, twitchings of the limbs came on and the patient died sixteen hours after the operation with a temperature at the time of death of 104.2°. There was free drainage up to the last.

Necropsy.—There were caseous mediastinal glands and acute tuberculosis of the lungs, liver and meninges of the brain. There was no lymph at the base of the brain and there were many tubercles along the vessels of the Sylvian fissure and in the velum interpositum. The pia mater

³ Brit. Med. Jour., Oct. 17th, 1891, and April 8th, 1893.

was adherent to the cortex. The ventricles were all dilated, with softening of the surrounding brain matter. The ependyma was rough and thickened over the optic thalami. The trephine opening extended to within half an inch of the foramen magnum and was a quarter of an inch from the middle line. The dura mater had been opened just over the outer side of the amygdala in a most favourable situation for drainage purposes. There was no trace of any injury done to the fourth ventricle or cerebellum by the probe used at the operation. The necropsy showed that death was inevitable, as the extensive softening caused by the pressure was an indication of great brain damage. I very much regret that the patient was so far gone before any operative measures were adopted, for the relief obtained by the operation was very marked and it seemed as though death would have occurred even earlier if nothing had been done. The appended diagram indicates the site of the trephine

Vertical section of base of skull immediately to the right of the median line. *a*, basal subarachnoid cavity and its relation to the cerebellum; *b*, fourth ventricle; *c*, site of trephine aperture in Case 3.

aperture and its relation to the subarachnoid space. The operation was really of a most simple nature and only took about thirty minutes, and I feel sure that this region of the brain is not so inaccessible as is usually thought. It is perhaps not sufficiently recognised that the superior surface of the cerebellum extends from the free margin of the tentorium in front to the lateral sinus groove behind, whilst the much more curved inferior surface extends from the lateral sinus groove to the upper border of the petrous bones. It follows that any opening made in the skull beneath the superior curved line of the occiput exposes the under surface of the cerebellum and is in close relation with the subarachnoid space. To my mind there is no doubt that this mode of drainage is most satisfactory, for, whether the openings between the fourth ventricle and the subarachnoid space are patent or not, they can easily be made so, but this will rarely or ever be necessary. In dealing with such a fatal disease as meningitis one is justified in trying anything that seems likely to be of use, and the withdrawal of over-secreted fluid seems to me to be a step in the right direction. An operation in this position would be equally advantageous for other cases in which the cerebro-spinal fluid is in excess and cannot but be regarded as preferable to spinal drainage.

The last point remaining to be noticed is that, whilst cerebro-spinal fluid may escape slowly for days without causing any bad symptoms, a rapid escape may lead to general convulsions and endanger life. It is better, for this reason, to drain by the insertion of a few strands of horse-hair or silk than by a drainage-tube, however small. From the marked relief noted in the cases under my care I feel justified in concluding: (1) That the relief of intra-cranial pressure and its effects, when due to over-secretion of cerebro-spinal fluid, is best obtained by the gradual withdrawal of that fluid; (2) that the best mode of doing this is by tapping the basal subarachnoid space in the way proposed; and (3) that by so doing there is a hope that cases of meningitis may be placed under more advantageous circumstances for recovery

and a decrease in their mortality obtained. Even if recovery does not take place, the operation seems to diminish considerably the severe distension pain which is so prominent a feature.

Hull, Yorks.

A CASE OF PNEUMONIA ASSOCIATED WITH FRAENKEL'S DIPLOCOCCUS.

By E. C. BOUSFIELD, L.R.C.P. LOND.

THE following case is of considerable interest from both the clinical and etiological points of view, especially as it bears upon the disputed question of the relative importance, as regards the causation of pneumonia, of the organisms associated respectively with the names of Fraenkel and Friedländer.

A strong, well-nourished woman, past the climacteric and not the subject of any constitutional disease, except some slight tendency to asthma, consulted me, through her husband, on Dec. 14th, 1892. The symptoms described appeared to be those of commencing bronchial catarrh and I ordered a diaphoretic and visited her early the next morning. I found her sitting up in bed, with flushed face and evident dyspnoea, the temperature was 103.8°, the pulse 120, and the respiration 60. There were no physical signs to account for the dyspnoea, no moist sounds of any kind, no dulness on percussion, or even diminution of resonance. The general condition was, in short, much more suggestive of a general infection of some kind than of a trouble localised even to the extent to which such a statement can be true of pneumonia. There being no indications for specific treatment, I contented myself with ordering a linseed and mustard poultice over the lungs behind, and continued the former mixture with the addition of aromatic spirit of ammonia. In the evening I found the condition of the patient practically unchanged, but on the following morning a small amount of a slightly blood-stained and extremely viscid expectoration was coughed up during my visit, and on examining it I found it to contain in enormous numbers—in fact, almost in a pure

Sputum of patient, $\times 1000$ diameters, stained in Weigert's methyl-violet for five seconds and washed with water. (From a photograph by the writer.)

state of cultivation—a diplococcus which from its reaction to Gram's staining I concluded to be that known as Fraenkel's pneumococcus. On cultivation this was established beyond the possibility of doubt, the organisms presenting all the characteristics of the diplococcus just named, even to the tendency, which I have repeatedly noticed in this organism, to assume, after passing through several generations on agar-agar, the characters of the erysipelas organism, as regards the number of cocci of which the chains are composed. The