On consideration of these facts it will be seen that the indications for treatment were all in the direction of endeavouring to bring about an increased degree of coagulability in the blood. In view of the general paucity of leucocytes in the blood, it was evidently worth ascertaining whether an increased coagulability could be brought about by increasing the number of the leucocytes. With a view to effecting such an increase, I put the patient upon daily 1 gramme doses of nuclein. I had prepared the nuclein, by Horbaczewski's method, from thymus glands. The leucocyte enumerations which are tabulated below confirm, as far as a single case can, Horbaczewski's observations of the occurrence of leucocytosis after the administration of nuclein. The enumerations were in all cases made three hours after the exhibition of the nuclein. The degree of leucocytosis is to be gauged by reference to the figures for the four preceding and three succeeding days (vide *supra* and *infra*).

Date.	Treat-ment.	Number of White Blood Corpuscles in 1 c.mm.	Varieties of White Blood Corpuscles.	Coagulation Time.
May 30th, 1893	1 g. nuclein at 12 noon	8,600	E. 2 P. 57 M. 10 L. 31	14 minutes(?)
May 31st, 1893	"	10,200	2 58 6 34	12 minutes
June 1st, 1893	"	10,200	1 58 10 31	10½ minutes

It will be noticed that the coagulability of the blood was not increased as compared with the three previous days. I therefore determined to try the effect of the internal administration of lime salts. I was influenced in this (a) by the results of my experiments on the administration of calcium chloride to animals, some of which have been already reported in the BRITISH MEDICAL JOURNAL⁶; (b) by the following experiments, in which I observed that an increase of coagulability was obtained when calcium chloride was added to the extravascular blood of this particular patient. The experiments were as follows:—

May 31st, 1893. Capillary tubes of standard size filled with blood from tip of finger. Tube 1 tested 8½ minutes after filling contents liquid. Tube 2, after 9½ minutes, liquid. Tube 3, after 9½ minutes, liquid. Tube 4, after 10 minutes, clotting. Tube 5, after 11 minutes, clotting. Tube 6, after 10 minutes, clotting. Tube 7, after 12 minutes, clotting. Tube 8, with addition of ¼ volume 1 per cent. CaCl₂ solution found clotted when tested after 6 minutes. Tube 9, with addition of ¼ volume of 1 per cent. CaCl₂ solution tested after 6 minutes, contents clotted. Tube 10, with ¼ volume 1 per cent. CaCl₂ solution clotted after 5½ minutes.

It will be noticed that we have here a reduction of coagulation time from 12 to 6 minutes as a consequence of an addition of calcium chloride to the extravascular blood. I have multiplied such observations on my own blood and upon other normal bloods of both man and animals, and find, as far as my experience goes, that such an acceleration of coagulation time is the invariable rule. Thus, for instance, my own blood clotted in 30 seconds with a lime addition at a time when its normal coagulation time was represented by 2½ minutes. Again, on another occasion, when the coagulation time of my blood was represented by 3 minutes, I found that my blood clotted in 45 seconds with the appropriate lime addition.

In view of the above facts I administered 1 gramme (*circ.* 15 grains) of calcium chloride three times a day to my hæmophilia patient. The results are tabulated below.

Date.	Treat-ment.	Number of White Blood Corpuscles in 1 c.m.	Varieties of White Blood Corpuscles.	Coagulation Time.
June 2nd, 1893	1 g. CaCl ₂ t. i. d.	7,200	E. 1 P. 47 M. 19 L. 33	5½ minutes
June 3rd, 1893	"	7,800	4 44 11 41	5½ minutes
June 5th, 1893	"	6,500	2 51 6 41	Over 1 hour

⁶ BRITISH MEDICAL JOURNAL, December 19th, 1891.

The administration of lime was thus immediately followed by a reduction of coagulation time to within normal limits. This normal degree of coagulability was also maintained on the next day. On the fourth day of the treatment, however, coagulability was found to be decreased to an extraordinary extent. At this stage my observations were unfortunately broken off by the departure of my patient.

In the absence of actual experiment, I have however the following reasons for surmising that the observed decrease of coagulability was due to the administration of calcium chloride having been carried too far (a) when too large an addition of calcium chloride is made to decalcified blood *in vitro* coagulability decreases,⁷ instead of being accelerated as it is with moderate additions; (b) on taking 2 grammes of calcium chloride three times a day I found that the coagulability of my blood rose during the first 24 hours, and then fell away to almost its original normal level (coagulation time 4 minutes) on the second day, and fell away further on the third day (coagulation time 6 minutes); (c) the greatest accelerations of coagulation time appear to be obtained with comparatively small doses of lime. Thus, in the case of my friend Dr. Leonard Rogers, coagulation time before administration of lime was 5½ minutes; it decreased in 24 hours after two 1-gramme doses of calcium chloride to 1½ minute. Again, in my own case,⁸ the effect of taking 2 grammes of calcium chloride in a single dose was a reduction of coagulation time from a normal of 4 minutes to 1½ minute 24 hours after the exhibition of the lime.

I believe that the facts which have been brought forward are sufficient to raise a strong presumption that calcium chloride will prove of utility in producing an increased coagulability of the blood such as is desiderated in the treatment of internal hæmorrhage, aneurysm, and hæmophilia. I have seen such arrest of hæmorrhage accompanied by an increase of blood coagulability in a case of perpetually recurring epistaxis and in a severe case of hæmoptysis, the opportunity of observing which last I owe to the kindness of Professor Cayley and Surgeon-Colonel E. Fairland. Similar successful results have been put on record in the BRITISH MEDICAL JOURNAL by Mr. Mayo Robson.

I may, in conclusion, refer to two sources of fallacy which might be supposed to vitiate the results arrived at in this paper. The observed increase of coagulability might evidently be attributed to some spontaneous variation of blood coagulability (such a variation might be conceived to be associated with the different stages of digestion); or, again, the alterations of blood coagulability might be attributed to differences in the gaseous composition of the blood in different experiments. As far as I have yet been able to study these questions, I see no reason to believe that these influences exercise a very large disturbing effect. In order, however, to minimise such sources of error in my experiments, I have in all cases made my estimations at the same hour on successive days, and I have invariably relaxed the ligature at frequent intervals whenever I have been drawing off blood from the finger.

A STUDY OF A CASE OF FOCAL EPILEPSY, AND OF THE RESULTS PRODUCED BY EXCISION OF A SMALL AREA OF THE MOTOR CORTEX.

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CASES in man which help to elucidate some of the difficult problems dealing with the functions of the cerebral cortex are so rare, that the following study of an instance in point may be interesting.

The patient had convulsive seizures of the right arm due to a sarcoma of the lower part of the left ascending parietal convolution. An oval area of cortex infiltrated with growth was excised. The piece taken away had the long axis antero-posterior, and extending from the fissure of Rolando in front to just across the lower extremity of the interparietal sulcus behind.

⁷ Wright, *Jour. of Pathology*, June, 1893, p. 444.

⁸ The condition of increased coagulability in this case was already apparent in 2½ hours. As in Dr. Rogers's case it passed off gradually on the third day.

I.—SENSORY SYMPTOMS.

Sensibility to touch, to pain, to heat and cold, and the capability of appreciating the addition of 1 oz. to 20 ozs. in the palm of the hand were absolutely unimpaired both before and after the operation. The attempt was made after the operation to see how readily the patient could localise cutaneous impressions, and she was often as accurate as a healthy person. No doubt she was sometimes very wide of the mark, wider indeed than either of three healthy persons tested, but I am not inclined to attribute much importance to this, for often she was quite accurate, and sometimes healthy people were very wide of the mark. Probably the excision of the arm area of the left cortex to some extent weakened the movements of the left arm, and consequently she would not be able to localise very correctly with it. She lay on her back, and therefore the left hand was usually a long way off the right arm, and localisation is always much less accurate the further the localising hand has to be brought to touch the part being investigated, this probably being only a special instance of the fact often observed in healthy people, that the accuracy of localisation is much greater the shorter the time which elapses between the touch and the attempt to localise it. Lastly, as she was aphasic, she was debarred from asking us questions which would enable her to find out whether she correctly understood our requests. On the whole, probably the power of localising impressions was very little, if at all, impaired.

In the few observations that were made with the pin head instead of the pin point the results obtained were the same. I wish I had tested sooner after the operation, and that more observations had been made with the pin head, for some think that however lightly the pin point is applied, it really is a test of the perception of pain and not of touch; but I find in my own arm I cannot localise touches with the pin's head any better or any worse than those with the point, and the point was, in the patient and in the healthy persons, always used so lightly that when I touched myself I was quite unconscious of any pain. Then also it must be remembered that, according to Ziehen, "pain, therefore, is no especial quality of sensation, but merely a special designation for the painful or unpleasant feeling which accompanies very intense dermal sensations."¹ Both in the patient and in the three healthy persons the accuracy of localisation was much greater below the elbow than above it, and was least about the shoulder.

Great importance attaches to the sensory condition of a part paralysed by excision of the cerebral cortex. Munk, as is well known, showed that if a large area of the motor part of the cortex is excised there is loss of sensation on the opposite side of the body. Dr. Mott has recently, with the chip test applied to monkeys, confirmed these results. In all these experiments a large area was excised, but in my case only a small portion was taken away. Some experiments recently performed upon monkeys, and related by Professor Schäfer at the Physiological Society, show that when a small area of the lower part of the ascending frontal convolution was excised there was no discernible loss of sensation in the paralysed part, but if the area excised was large there was loss of sensation. My case therefore supports, I think, the results of experimental physiology. A case just published also supports it.²

I have read a great many descriptions of cases of tumours of the brain to see what light they throw on the question of the state of sensation after damage to the motor cortex, but I am convinced that they are useless as an aid to its settlement. In the first place many are very badly reported; secondly, a tumour is always of slow growth, the effects of lesions slowly produced are often widely different from the results of those quickly produced; thirdly, a tumour often sets up surrounding inflammatory changes; fourthly, the increase of intracranial pressure produced by a cerebral tumour is frequently so great that it will cause, as I have elsewhere³ shown, absorption of half the thickness of the skull, even when it is not itself in contact with the bone; fifthly, different authors often interpret the same case differently.⁴

It seems to me, therefore, that the question can only be settled by observing cases in man, in which a limited area of the cortex is excised. These cases must fulfil the following conditions: 1. They must be accurately reported and ob-

served for all varieties of sensation. 2. If any defects of sensation are observed, it must be shown by a *post-mortem* examination that the only lesion in the brain is that produced by the operation. The absence of a necropsy, as the patient had previously had meningitis, renders even Dr. Ransome's case⁵ inconclusive. So few published cases fulfil the above conditions, that the time has hardly arrived for them to be collected and analysed.

II.—THE NUMBNESS IN THE RIGHT HAND WHICH PRECEDED THE FITS.

It has often before been noticed in cases of Jacksonian epilepsy that the fits are preceded by numbness in the part in which they occur. The noteworthy point in my patient is that after excision of the piece of the cortex she never had any numbness. This has been observed in other cases, and with our present state of knowledge there is no entirely satisfactory explanation of it, but it is to some extent a support of the view that the motor area of the cortex has sensory attributes.

III.—THE MOVEMENT OF THE HEAD.

In the few fits in which there was any movement of the head it was jerked to the left, that is to say, it was turned towards the side on which the lesion existed. Now Beevor and Horsley⁶ found when they excited the cortex of the orang-outang on one side, the head and eyes were turned to the opposite side. My case, therefore, indicates a marked difference between man and the orang-outang in the representation on the cortex of the muscles which turn the head. Mr. Rushton Parker and Professor Gotch⁷ have also observed a case in which in the natural fits and after electrical excitation of the cortex on one side the head was turned to the same side.

IV.—THE TEMPERATURE.

For the first three days after the operation this varied from 1° to 2½° F. above normal. It then was about normal till a week before death, during which it was from 1° to 3½° above normal; but at whatever figure it stood, it was almost always higher in the right axilla (on the opposite side of the body to that on which the cortex was excised) than in the left. The difference was usually about 1° F.; on one occasion it was as much as 3° F. It was taken in both axillæ on 223 occasions. It was higher in the left axilla on 19, it was the same in each axilla on 4, and was higher in the right on 200 occasions. Although we carefully looked for it, at no time could any difference of the vascular dilatation of the cutaneous vessels in the two axillæ be detected. It is well known that after a lesion of one corpus striatum the temperature is not only raised,⁸ but is often higher in the opposite axilla than in that on the same side. I have recorded experiments and clinical cases showing this,⁹ and also that after operations upon the cortex of the brain in animals,¹⁰ and damage to it in man,¹¹ a rise of temperature is often produced; but as far as I know, this is the first case in which systematic observations of the temperature in both axillæ have been made in a case in which a definite area of the cortex has been excised, although both Dana¹² and myself have recorded cases of a unilateral rise of temperature after softening of the cortex on the opposite side. Dr. Washbourn and I¹³ investigated the temperature of the groin in rabbits, and came to the conclusion that when a unilateral lesion of the cortex caused a rise of temperature, both groins were equally affected. It would appear that rabbits and man are different in this respect.

It has been noticed in other cases that after excision of a limited area of the motor region there is paralysis of the parts corresponding to neighbouring areas, and therefore we were hardly surprised to find that our patient had aphasia and paralysis of the face, tongue, and leg after the operation. Probably the reason why these symptoms did not completely pass off was the very rapid development of the other growths which were found after death. It will be noticed that in this patient the march of the fits was the same as is often observed, and that she never had a single fit after the cortex was excised.

The patient, a woman aged 41, was first seen by me on January 4th, 1893. She had two and a-quarter years ago had the left breast removed for malignant disease. She said that for some weeks previously she had suffered from slight numbness in the right hand. On the evening of January 3rd she had her first fit, and subsequently she had about fifteen

severe and some slighter fits every twenty-four hours till the operation. I need only describe one, for Dr. John Smith, with whom I saw the case, the house physician, and clinical assistants at Guy's Hospital, and I myself agreed that the fits were all similar, except that they differed in degree. The patient knew when a fit was coming on by a sensation of numbness and tingling in the right fingers and thumb. Then in less than a minute there were a series of rapidly-repeated extensions of the right wrist and metacarpo-phalangeal joints. At the same time there were a series of rapid abductions of the hand to the ulnar side. The next stage consisted of rapid flexions of the phalangeal and metacarpo-phalangeal joints, so that the fingers were dug into the palms of the hands, causing considerable pain. Then followed a series of rapid flexions and extensions of the elbow, after which the fit was over. It usually lasted, exclusive of the stage of numbness, about ninety seconds. The slighter fits were much shorter, and consisted only of a little movement of the fingers. In a few, after the flexions of the elbow, the shoulder was for a few seconds rapidly adducted and abducted, and the head was jerked to the left. It is said that she was unconscious after the first fit, but those observed by us were never followed by unconsciousness.

In between the fits the right upper extremity was in all movements weaker than the left. The hand lay pronated, and the supinators were unable to move it. On the right side she could only move the dynamometer to 50, but on the left to 90. There was no paresis of the muscles of the head, face, eyes, tongue, trunk, or lower extremities. Both knee-jerks and both plantar reflexes were present, but were better marked on the right than the left. There was no clonus of either knee or ankle. Both elbow-jerks were absent. Both wrist-jerks were present, that on the right being exaggerated.

She was an intelligent woman. Sensibility to touch, pain, and temperature was quite normal over the whole body. In the right hand she could easily tell the addition of 1 oz. to 20 oz.

The fields of vision were normal; she recognised colour and form correctly. The pupils were equal, and reacted well. There was no ocular paralysis. There was early optic neuritis in the right eye, the left was normal. Smell, taste, and hearing were all normal. The diagnosis was made of a growth on the cortex of the left cerebrum implicating the arm area, and secondary to the disease of the breast. The fits were so frequent that the patient desired an operation, although she was told that it would not prevent other secondary deposits.

On January 6th Mr. Arbuthnot Lane exposed the middle of the fissure of Rolando. Over an area which as nearly as could be judged corresponded with the part of the arm area in the ascending parietal convolution, the cortex at one part was of a rather more brownish-green tint than was normal. This part was cut away to such a depth that white matter was exposed. When frozen and cut, it clearly consisted of growth. At the operation it was not definitely marked off from healthy grey matter, which it resembled so closely that several considered it to be healthy.

January 7th. There is paralysis of the whole of the right face, except the orbicularis palpebrarum and the occipito-frontalis. No ocular symptoms. The tongue lies on the floor of the mouth quite motionless. The right upper and the right lower extremities are completely paralysed, but no sensory defect is noticeable. She is completely aphasic.

January 8th. The condition is the same, except that the right pupil is larger than the left, and last night it was observed that the right side of the face was sweating, although the left was quite dry.

January 11th. Her condition is unchanged, except that the tongue can be protruded a little; the facial paralysis is less marked and the pupils are equal.

January 14th. The movements of the facial and lingual muscles are still improving. She can slightly move the right toes, and can detect 1 oz. added to 20 oz. in the right palm.

January 19th. She has still further regained the power of movements of the face and tongue; the movement of the right foot has ceased to improve. She can say five or six words distinctly.

January 22nd. She can still feel the slightest touch of the skin in any part of her body, including the right upper extremity.

The power of localisation of sensations was tested in the following way: She was blindfolded. Some spot on the right upper extremity was touched with a pin point as lightly as possible, and she was asked to touch with her left fingers the spot touched. The spot touched and the spot she indicated as being touched were both marked. This was done on many parts of the right upper extremity, and similar experiments were carried out on the right upper extremities of two healthy women and one healthy man. A comparison of the results showed that the patient and the three healthy individuals were in the majority of instances quite accurate; that sometimes all four were inaccurate, and then the distance between the spot touched and that to which the touch was referred varied from $\frac{1}{4}$ inch to $2\frac{1}{2}$ inches. The patient was a little less accurate than the healthy persons, but the difference was not great. In all cases the subject was more likely to be accurate if the pressure of the pin was firm, and if there was no delay between the attempt to localise and the touch. All four subjects were more correct below the elbow than above it. It was impossible to test the patient's left upper extremity owing to the paralysis of the right. A few experiments in which the head of the pin was used instead of the point gave the same result. These experiments were repeated on other days than this, but always with the same result.

February 7th. Optic neuritis still present. Up to this time her condition since the last note has not changed, but from this date she became drowsy, her pulse was very slow, she had cerebral vomiting, and she sank and died on February 13th, it being clear that there were other deposits in the brain.

She never had a fit after the operation, nor had she any numbness. Her mental condition was quite good till February 7th. She never had any anaesthesia; pain was localised as such; and her temperature sense was normal. The temperature was usually different in the two axillae.

Post-mortem Appearance of the Brain.—The gap left by the piece of grey matter removed was oval, and occupied the position shown in the figure. It was limited in front by the fissure of Rolando, behind it extended slightly on to the supramarginal convolution, its long axis just crossing the lower interparietal sulcus. The floor of the area removed exposed white matter, soft and discoloured here and there with shreddy filaments

of growth. There were secondary growths, all of which had evidently recently grown very rapidly in the upper part of the left ascending

The shaded part indicates the area excised.

parietal, in the posterior part of the third left frontal, in the upper part of the left angular and in the middle of the right ascending frontal convolutions. The presence of these makes it unprofitable to study the aphasia, the paralysis of the face, arm, and tongue, or to seek for changes in the spinal cord.

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THE NEUROGLIA ELEMENTS IN THE HUMAN BRAIN.

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THE present preliminary account deals only with the neuroglia elements in the human brain. The research was begun at University College in May, 1892, and continued at the laboratory of the West Riding Asylum since January last. The whole material examined consists of twenty-seven human brains, and the regions studied were the ascending frontal, the occipital (or calcarine), and the hippocampal regions of the brain.

Among animals studied were foetal, young and adult cats, adult rats, rabbits, cats, and the ox; the results obtained from these confirm in the main features those obtained in the human brain. While in the human brain the nerve elements have been largely and extensively studied both in health and in disease, the neuroglia elements have been comparatively neglected, partly owing to a widely-spread belief in a mere passive rôle they were supposed to play, and partly owing to inadequacy of the methods used, for while the general and special methods with the anilines, picro-carmin, osmic acid, hæmatoxylin, and gold chloride—to mention only the chief—have shown much of the nerve elements, a method has been wanting which should not only exhibit the former elements down to their finest ramifications and actual endings, but should do the same for the neuroglia elements with faithfulness and precision, so as also to demonstrate the relations of these two elements to another and to the ground substance.

This is now possible by Golgi's method of staining with silver chromate, which since 1886 marked an epoch in neurology of which the publication of his great work *Sulla fina Anatomia del Sistema Nervosa* was the beginning of a revolution