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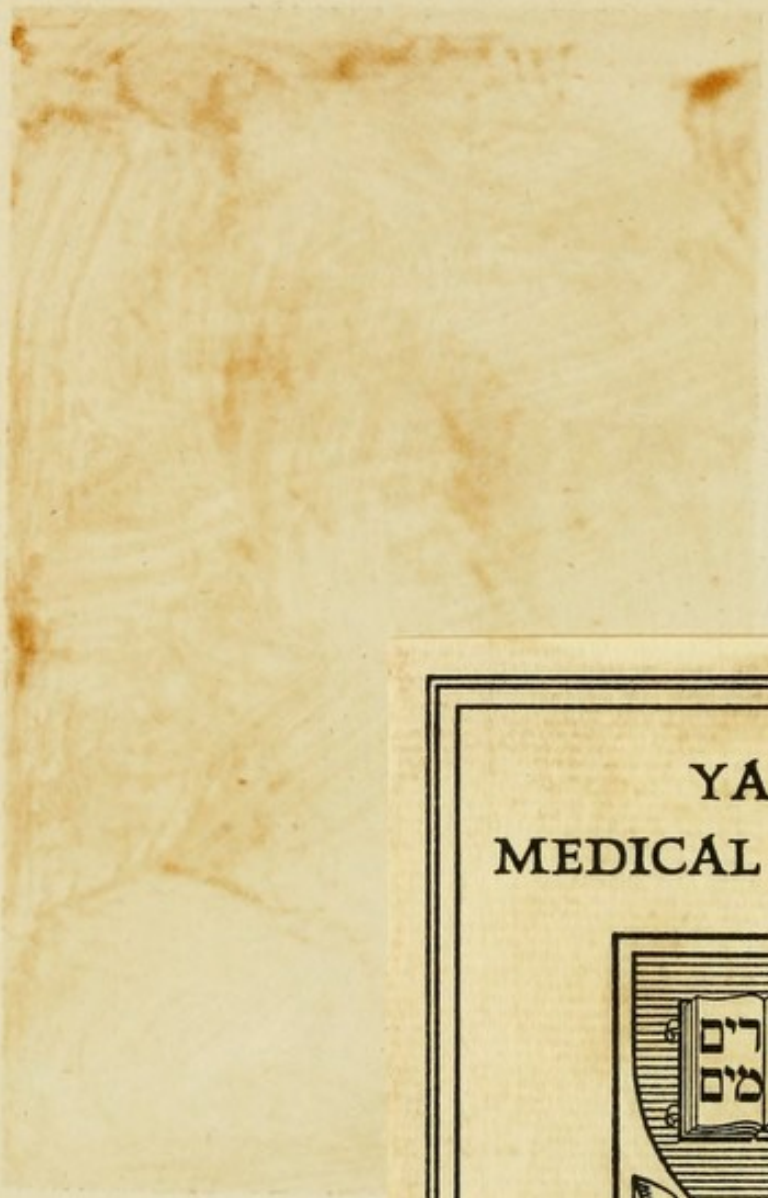
OBSERVATIONS

ON

INSANITY, &c.

DR. CLOUSTON.

18691



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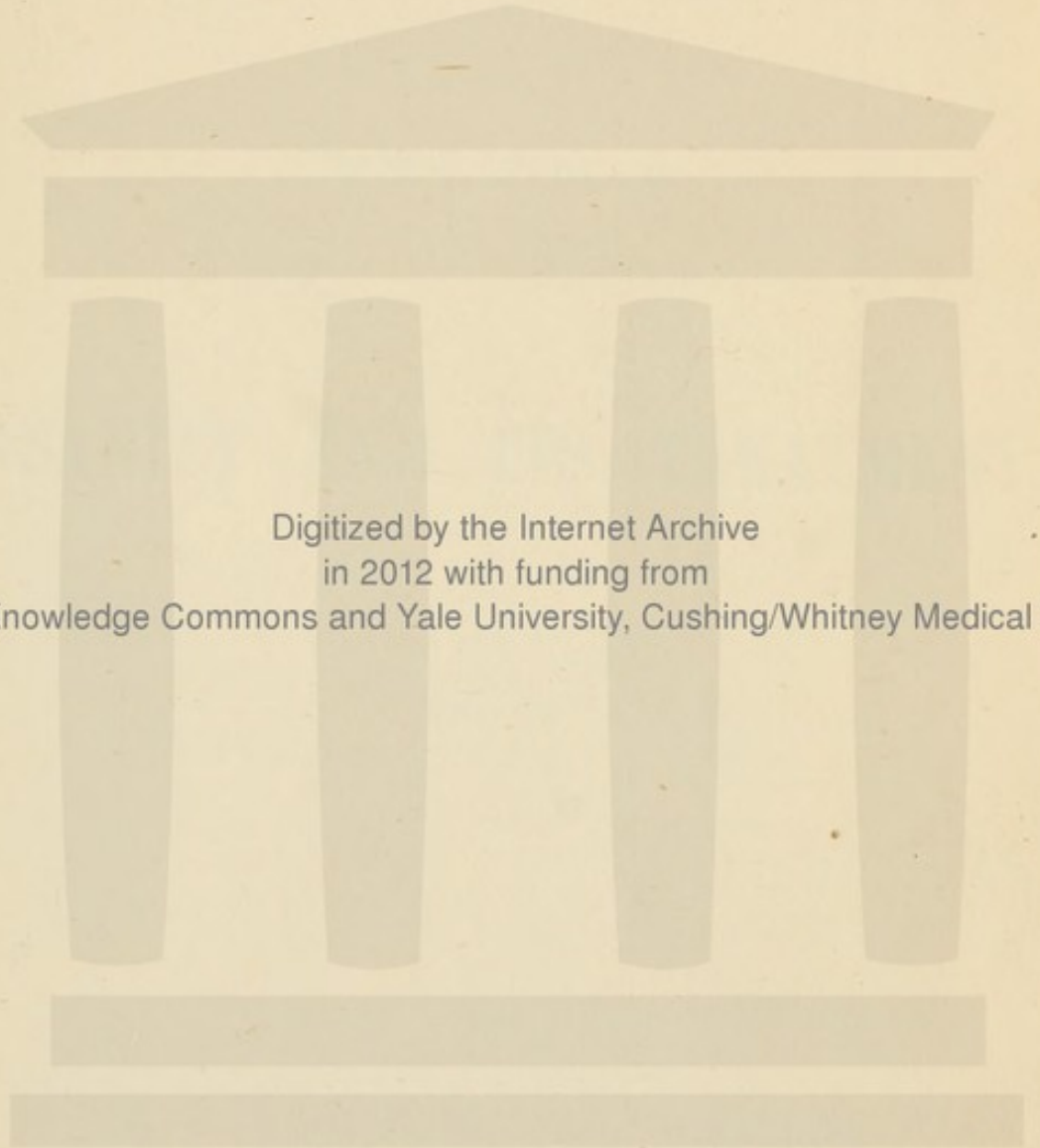

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Dr Tolly
with Dr Clouston's Compts

CONTRIBUTIONS

TO THE STUDY OF

INSANITY AND ITS TREATMENT,

&c., &c.

BY

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LIST OF PAPERS.

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THE CONNECTION

BETWEEN

TUBERCULOSIS AND INSANITY.

BY

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(*Read before the Medical and Chirurgical Society of Edinburgh, February* 11, 1863.

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1863.

THE CONNECTION

BETWEEN

TUBERCULOSIS AND INSANITY.

BY

T. S. CLOUSTON, M.D.

From the time of Hippocrates downwards a special connection has been assumed to exist between certain forms of insanity and diseases of the abdominal organs, but it is only recently that diseases of the lungs have been ascertained to have any relation to mental derangement. Arnold,* who epitomised everything known about insanity before his time, does not mention any disease of the lungs among even the "remote causes" of insanity, although he includes among these, diseases of almost every other organ of the body. Esquirol† and Georget‡ were the first to show the frequency of lung disease among the insane. Burrows§ and Ellis‖ were the first to refer to the frequency of phthisis pulmonalis among the insane in this country; but the subject has scarcely received that attention from the profession which its importance and interest demand. Dr. McKinnon¶, the first Medical Superintendent of the Royal Edinburgh Asylum, came to the conclusion that "the scrofulous and insane constitutions are nearly allied." Dr. Skae, in his annual report for 1847, remarked the great frequency of tubercular deposits in the bodies of those dying insane. Dr. Hitchman** estimated that 20 per cent. of the deaths among the females in Hanwell Asylum were from phthisis, and Sir Alexander Morrison says that, out of 1428 deaths that occurred in patients who had

* Arnold, 'On Insanity,' vol. ii.
† Esquirol, 'Des Maladies Mentales,' tom. ii.
‡ Georget, 'De la Folie.'
§ Burrows' 'Commentaries on Insanity.'
‖ Ellis, 'On Insanity.'
¶ 'Annual Report of the Royal Edinburgh Asylum,' 1845.
** 'Psychological Journal,' vol. iii.

been under his charge, 164, or 11·5 per cent., were from pulmonary consumption, and 4·7 per cent. from other allied lung diseases. According to the Registrar-General's returns, the proportion of deaths from tubercular diseases in this country is between 16 and 17 per cent. of the total number of deaths at all ages, and phthisis pulmonalis alone is the assigned cause of death in about 12 per cent. No fair comparison can be instituted between this rate of mortality and that among the insane, because the Registrar-General's returns include the deaths among children, while the insane, as a general rule, have attained the adult age. Taking the returns from the eight principal towns in Scotland for the year 1861, where the Registrar gives the number of deaths at four periods of life, we find that phthisis pulmonalis was the assigned cause in 21 per cent. of all the deaths above five years of age, and in about 20 per cent. of all those above twenty. The deaths among the insane under twenty are so rare that the latter per-centage forms the best standard of comparison. There have been 1082 deaths in the Royal Edinburgh Asylum between the years 1842 and 1861 included, and phthisis pulmonalis was the assigned cause in 315 of them, or in nearly one third. There were 591 deaths among the men, and 136 of these were from this cause; and 491 deaths among the women, of whom 179 were from phthisis; being 23 per cent. of the males and 36 per cent. of the females. I have gone over the obituaries attached to the reports of most of the English county asylums for the last five years, and I find that phthisis is the assigned cause of death in only 13 per cent. of the males and in 18·6 per cent. of the females. In the asylums, however, in which the causes of death are determined to any extent from post-mortem examinations, phthisis stands as a much more frequent cause of mortality than in others where this is not the case. When such expressions as "exhaustion," "general decay," "natural decay," "marasmus," are put down as the "causes of death," in 10, 15, and in one as high as 60 per cent. of the cases, we cannot arrive at any correct idea of the true causes of mortality in asylums. "Consumption and lung diseases" are the causes of death in 22·5 per cent. of the males and 32 per cent. of the females who have died in all the public asylums of Scotland for the last four years, according to the reports of the Commissioners in Lunacy.

In eight of the North American asylums the deaths from consumption amount to 27 per cent. of the whole, according to Dr. Workman.* He remarks that the deaths from consumption in the New York city asylum are twice the rate per cent. of any of the others, except his own at Toronto, and says, "I am strongly inclined to the belief that the New York city asylum records of

* 'American Journal of Insanity,' July, 1862.

mortality have been based, to a large extent, on post-mortem evidences rather than on ante-mortem suppositions."

In the time of Georget* phthisis was the cause of death in more than one half the cases in the Salpêtrière. He also states that in three fourths of the bodies of the insane examined by him he found thoracic diseases. Esquirol says that two cases of insanity out of eight are affected with thoracic disease. He also mentions scrofula as one of the causes that predispose to insanity. There is but little reference made to this subject in recent French psychological literature.

In the asylum at Prague we shall see how frequently tuberculosis occurs among the patients. Leidesdorf† remarks the frequency of phthisis among the insane in Vienna. Dr. Geerds seems to think that phthisis is not more common among the insane, than among the sane.‡ In Holland Schroeder van der Kolk§ noticed the frequency of phthisis among the insane, and the relationship between the two diseases.

The following is a tabular view of the *assigned* frequency of phthisis as a cause of death.

Table I.

	Per Cent.		
	Male.	Female.	Both sexes.
Royal Edinburgh Asylum since 1842 .	23	36	29
English county asylums for last five years	13	18·6	15·5
Hanwell (Hitchman) . . .	—	20	—
Sir A. Morrison's, 1428 cases . .	—	—	11·5
Scottish public asylums since 1858 .	25	32	26·7
Bethlem Hospital from 1846 to 1860 (Hood)	11·7	18·3	15·3
Seven North American asylums (Workman)	—	—	27
Salpêtrière (Georget) . . .	—	—	50

But to arrive at anything like correct conclusions as to the extent to which tuberculosis prevails among the insane, we must examine carefully the records of a sufficient number of post-mortem examinations, and not trust at all to the *apparent* death-rate from phthisis and tubercular diseases. Among the majority of the insane, the

* Georget, 'De la Folie.'
† Leidesdorf, 'Pathologie und Therapie der Psychischen Krankheiten.'
‡ 'Allgemeine Zeitschrift für Psychiatrie,' 1861.
§ A case of atrophy of left hemisphere of brain (Syd. Soc. Trans.).

diagnosis of disease is a matter of uncertainty and doubt, the precise causes of death cannot be definitely known without post-mortem examinations—frequently not even by this means—and nothing but an exact statement of the frequency of tubercular deposit in the body, and a comparison of this with its frequency among the sane, can give us satisfactory results. Even when this has been done we have only got a few simple pathological facts, and must examine into the history of each case during life—the history of the insanity, and the history of the tuberculosis—before we can attempt to determine what relation they had to each other, and which of them was first developed.

Dr. Skae has kindly allowed me to go over the records of 463 post-mortem examinations that have been made, under his own superintendence, in the Royal Edinburgh Asylum since 1851, and from the case-books of the institution I have been able to get a tolerably complete history of each of these cases, both before their admission into the asylum and afterwards. I tabulated as much of the information thus obtained as I could, and made a separate record of what could not be so systematically arranged. From the 'Pathological Register' I was able to discover in how many cases there was tubercular deposit in each lung, the peritoneum, the other abdominal organs, and the brain; and in how many of those cases the brain was diseased. I divided the cases into those in which there was slight tubercular deposit and those in which there was much, including among the former all the cases of calcareous deposit that had evidently been tubercular, but not those where there were only cicatrices of tubercular ulcers that had fully healed. The cases in which there was "much deposit" included all those in which the quantity of the deposit was really large, or those in which the tubercle was evidently in an active state of deposition or disintegration. Had I been able to classify them into old tubercular deposits and recent deposits, it would have been still more satisfactory; but this I found to be impossible. In a few cases there were evidences of its having been deposited for a long time, from there being old cavities lined by condensed tissue, or from chalky deposits, and in other cases there were unmistakable signs of its being newly deposited; but the majority did not present characters so decided as to enable one to tell the date of the deposition; frequently there was both old and recent tubercle in the same lung. From the case-books I ascertained the age, the duration and the form of the insanity, the number of cases in which there had been previous attacks or hereditary predisposition, the existence in each case of suspicions, hallucinations, or suicidal tendency, the history of the tuberculosis during life if there were any signs of its existence then, the length of time in the asylum, and the form of insanity at death. In addition to the foregoing information, which I could

tabulate, I arranged the cases into such natural groups as were suggested to me by their resemblance to each other.

Taking the 463 cases, tubercular deposit was found in 282, or 60·9 per cent. There were 263 males, and tubercular deposit was found in 136, or 51·7 per cent. In the 200 females it was found 146 times, being 73 per cent. The distribution of the deposit among the organs of the body is seen in the following table.

Table II.

	Males.	Females.	Total.
Total number of cases found tubercular .	136	146	282
Lungs	133	144	277
„ much deposit	108	105	213
„ slight deposit	25	39	64
Deposit in right lung	115	130	245
„ left lung	124	131	255
Peritoneum	9	18	27
Nervous centres	6	2	8
Other organs (not including intestines) .	13	9	22

The frequency of this deposit seems at first startling, and we naturally ask if the number of cases here stated is not above the average, even among the insane. That nearly two thirds of all those who die in asylums should be affected with this one pathological lesion would indicate, without doubt, a special connection between it and insanity. Unfortunately I have no means of comparison with the statistics of the post-mortem appearances in any considerable number of the insane elsewhere in this country. Dr. Webster has described the post-mortem appearances in 115 cases that had died in Bethlem Hospital.* He found that in 49 of these there was tubercular deposit in considerable amount, but he does not seem to include those cases in which there were only slight deposits of tubercle in the lungs. These latter, although unimportant in themselves, indicate that a tendency to tuberculization exists. The same remark applies to the summary of post-mortem appearances given in the "Obituaries" of Dr. Boyd's admirable reports of the Somerset County Asylum. He found that tuberculization existed as a *cause of death* in 16 per cent. of the 539 cases in which autopsies had been performed.† As Dr. Boyd attributes the extraordinary proportion of 27½ per cent. of those cases to pneumonia as a cause of death, we can scarcely help concluding that many of these

* 'Psychological Journal,' vol. viii.

† 'Annual Report of Somerset County Asylum,' 1861.

must have been cases of tubercular pneumonia. Dr. R. Fischer* gives the details of 314 autopsies performed under the superintendence of Prof. Engel at the asylum at Prague. The following abstract of his observations, which I have made, shows the frequency of tubercular deposit.

TABLE III.

Total cases examined	314
Lungs tubercular	151
Of which the tubercle was obsolete in .	62
Right lung	143
Left lung	119
Peritoneum	10
Abdominal organs	6
Nervous centres	2

About one half of the cases are thus seen to have presented tubercular deposits.

We shall now compare those results with the frequency of tubercular deposits among the general population. Louis says that, of 358 cases that died in La Charité, 127 died of phthisis, and in 40 more tubercles were found in the lungs, so that in nearly one half there was tuberculization. Dr. T. K. Chambers has published the results of 2161 carefully performed and recorded autopsies at St. George's Hospital.† He found tubercular deposit in 550 of those, or in about a fourth of the whole. His results as to the frequency of tubercle in the two sexes were remarkable, for he found it in about 27 per cent. of the men and only in about 22 per cent. of the women. The disease is more common in females among the general population, as is the case among the insane.

Whether, therefore, we take phthisis as the assigned cause of death, or tubercular deposition in the body, tuberculosis is much more common among the insane than among the sane. Three persons die of phthisis in the Royal Edinburgh Asylum for every two who die in the eight principal towns of Scotland above twenty years of age. For every five bodies in which tubercular deposit was found in St. George's Hospital with tubercular deposition in them, twelve were found in the dissections made in the Royal Edinburgh Asylum. For every two persons dying of phthisis in La Charité, there were three in Salpêtrière.

Phthisis was the "*assigned cause of death*" in only 73 of the 136 men, and in 97 of the 146 women in whose bodies tuberculosis was found. This shows better than anything else how inadequate and erroneous an idea we should have if we estimated the prevalence of the pathological lesion according to the assigned frequency of its

* 'Pathologisch-Anatomische Befunde in Leichen von Geistes kranken,' R. Fischer.
† 'Med. Times and Gazette,' 1852.

principal symptoms. All the cases in which *lung diseases* are the assigned causes of death only amount to 189 out of the 282 with tubercular deposit. For the sake of showing how many diseases may be associated with tuberculosis, I have given in the following table the assigned causes of death in all the cases.

Table IV.

Assigned causes of death.	Male.	Fem.	Total.	Assigned causes of death.	Male.	Fem.	Total.
Abscess of liver	0	1	1	Brought up	20	26	46
Abscess of lung	0	1	1	General paralysis	24	6	30
Apoplexy	1	7	8	Hanging	1	1	2
Arachnitis	3	1	4	Hydrothorax	1	1	2
Ascitis	0	1	1	Morbus cordis	2	1	3
Bright's disease	1	4	5	Paraplegia	1	0	1
Cancer of bladder ...	1	0	1	Peritonitis	2	3	5
Cancer of lip	1	0	1	Phlebitis.....	2	0	2
Cancer of stomach ...	1	0	1	Phthisis	73	97	170
Cancer of peritoneum...	0	1	1	Pleurisy.....	2	2	4
Chronic bronchitis ...	1	3	4	Pneumonia.....	4	1	5
Chronic gastritis	1	1	2	Ramollissement	2	1	3
Cirrhosis of liver	0	1	1	Scrofula	1	0	1
Diarrhœa	3	2	5	Strangulation of bowels	1	0	1
Dysentery	2	1	3	Suppuration of kidney	0	1	1
Empyema	0	1	1	Tubercular meningitis	0	1	1
Epilepsy	3	0	3	Tubercular peritonitis	0	4	4
Erysipelas of leg	1	0	1	Ulceration of intestine	0	1	1
Gangrene of lung	1	1	2				
	20	26	46		136	146	282

Pathology of the brain among the tubercular.—In the majority of the cases the brain did not present any very well-marked pathological lesion. By well-marked I mean a decided change of structure that could in any way be directly connected with the tuberculosis, or sufficient to account for the insanity. In eight of the cases there was tubercle in the nervous centres, and in ninety more of them, including the general paralytics, there were organic changes in the brain Ramollissement, thickening, and morbid adhesions of the membranes, granular ventricles, and intense hyperæmia, were the chief of these well-marked deviations from the normal standard. But in addition to these, there was in nearly all the others a state of the brain which, although often found in cases of dementia without tuberculosis, yet seems to me to be more common in phthisical cases than in any others. There was great anæmia of the gray substance, with more or less atrophy of the convolutions and dropsy of the membranes and of the brain itself, while the white substance was soft and pale generally, with irregular patches where the punctæ vasculosæ were more numerous than usual. The white substance was especially softened in the fornix and its neighbourhood; sometimes, indeed, being quite diffluent at that part. Louis notices this softening

of the fornix in many of his cases of phthisis who were not insane, and associates the lesion with the tuberculosis.* Louis did not find the brain diseased more frequently among the phthisical than among those who had died of other diseases, and Dr. Chambers confirms his observations on this point by larger statistics. The state of the brain I have described gives much more the impression of an ill-nourished than of a diseased brain. The unequal vascularity of the white substance seems like the local congestions that occur in organs whose circulation is feeble. The arachnoid is frequently thickened; but as this is such a common condition in brains whose functions during life have been unimpaired, not much importance is to be attached to it.

In the appendix to the report of the Royal Edinburgh Asylum for 1854, Dr. Skae, when speaking of the specific gravity of the brain, says,—"On examining my cases in detail, I find that in most of those cases where the specific gravity of the gray matter was considerably below the mean, the patients had died of phthisis." This observation was made quite independently of any theory as to the relation between phthisis and insanity, and is a very important confirmation of the conclusions at which I have arrived from an investigation into the clinical history and pathological lesions of the cases of tuberculosis among the insane.

Tubercle in the nervous centres.—In eight of the cases there was tubercular deposit in the brain or its membranes or the cerebellum. This is, as nearly as possible, the same per-centage as Chambers found in the sane, taking all the cases examined; but taking the tubercular only, nearly 6 per cent. of Chambers's cases had the deposit in the nervous centres, while scarcely 3 per cent. of the cases examined in the asylum had tubercular deposit there. Ancell's per-centage is only 1·5 in 647 cases of tuberculosis in the adult collected by him. Of the eight cases, six were men and two women, and this more frequent occurrence of tubercle in the nervous system among males agrees with Chambers's observations. It might be supposed, *à priori*, that brain diseases being more common among the insane than among the sane, and tubercular deposition also more common, tubercle in the brain would be more frequent in the former. Such, however, we have seen not to be the case. Nerve-tissue seems to be almost exempt from tubercular deposition, for of the eight cases there were only two in which the tubercular deposition had not evidently commenced in the membranes. In those two cases there were large masses of tubercle in the cerebellum. The depth to which the convolutions extend in the cerebellum makes,

* Dr. Chambers found "idiopathic inflammation of the membranes of the brain," a condition which he thinks is almost peculiar to the tubercular, in 2·7 per cent. of his cases. The expression is so vague, and the brain so frequently diseased among the insane, that it is impossible to confirm his observations on this point in any way.

it probable that even in these the original nucleus of tubercular matter had been deposited in the pia mater at the bottom of the sulci, and had extended towards the centre of the organ, encroaching on the white substance and corpus denticulare. In two other cases there were masses of tubercle extending inwards among the cerebral convolutions, but they were in contact externally with the membranes. This is quite in accordance with the view of the origin of tubercle propounded by Virchow, and now so generally held by histologists of eminence. He believes, and indeed professes to have demonstrated, that tubercle is the result of an altered and increased development of the nucleated cells which exist in the ordinary connective tissue, or of the epithelium-cells. Now, although connective tissue has been demonstrated to exist among the nerve-fibres and nerve-cells of the brain and spinal cord, yet it is in such small quantity and of such a kind that its nuclei do not readily undergo the altered development into tubercle. In the pia mater and arachnoid, on the contrary, both connective tissue-corpuscles and epithelium-cells abound, and the tubercle is developed in them accordingly. In one of the cases the only parts tubercular were the choroid plexuses of the lateral ventricles. The most frequent site of the tubercular deposition was on the membranes over the hemispheres, or between the brain and cerebellum.

In only one case was the tubercular meningitis at the base of the brain, and it was not confined to the anterior part, but extended to the pons and medulla. In no case, therefore, was there any analogy to the ordinary tubercular meningitis of the child.

I am not to be understood as saying that tubercle cannot be developed in the cerebral substance. Such high authorities are in favour of that view that it would be presumption in me to do so. Guislain* expresses his decided conviction that it may be developed in the medullary brain-substance. Rokitansky holds the same view. Ancell says that tubercle of the brain rarely coincides with tubercle of the membranes; but if he means by this that tubercular masses extending into the cerebral substance are rarely associated with deposit in the membranes, his observation is very decidedly contradicted by the cases of which I have given a summary. Of fifty cases in which Dr. Chambers found tubercle in the nerve-centres, only eight were of the membranes. We cannot help thinking that he has included with tubercle of the membranes merely those cases in which they were covered with small, gray granulations, and has enumerated every example of soft, yellow tubercle, as in the brain, even though it was in contact externally with the membranes.

In every one of the eight cases there was tubercle in the lungs. In three of the cases there was tubercle of the peritoneum and of nearly all the abdominal organs, and in two of them, tubercular

* 'Leçons Orales sur les Phrenopathies,' tome ii.

caries of the bones. In three of the cases the tubercles in the lungs were in small quantity, and apparently stationary, and in one, the only evidences of tuberculosis in the body elsewhere were cretaceous masses in one lung.

In five of the cases the age was between twenty and thirty, in two between sixty and seventy, and in one sixteen. Four of the cases were demented, and had been for a considerable time in the asylum; two were cases of epilepsy, in only one of which, however—a boy of sixteen, in whom the fits came on a month before death—the disease could be ascribed to the tubercular deposition within the cranium; one was a case of general paralysis, and one monomania of suspicion.

Dr. Chapin * has collated seventy-four cases of tubercle of the brain, only sixteen of which, however, were above the age of twenty; so that the symptoms which he connects with the disease must be held to indicate more the acute hydrocephalus of the child than the disease in the adult. The symptoms he mentions as being generally present are convulsions, paralysis, cephalalgia, and mental impairment. He says that the cases occur in the scrofulous diathesis most frequently. In three only of the eight cases to which I have referred were there any cerebral symptoms that could be ascribed to the tubercular deposit. One of these was the boy of sixteen who had epileptic fits for a month before death, and for the last few days laboured under the ordinary symptoms of inflammation of the membranes of the brain, viz., squinting, paralysis, and coma. Another man had hemiplegia for fourteen days before death, and a woman who had laboured under monomania of unseen agency, was seized ten days before death with weakness, inclination to roll over on one side, and paralysis, which passed into coma. It was in this case that there was found tubercular meningitis over the whole base of the brain, medulla, and cerebellum. In the other five cases there were no symptoms whatever during life that could be ascribed to the pathological lesion, although in one of them there was a large tubercular mass occupying the greater part of the medullary substance of the cerebellum, in another the pia mater over part of both hemispheres and in the fissure of Sylvius was covered with small nodules of tubercle that were partly imbedded in the cortical substance, in another there were large masses of tubercle in the cerebellum and posterior hemispheres of brain. In only one third of Dr. Chapin's cases was there tubercular deposition in other organs; but in this, as in other respects, he lessens the value of his memoir by not distinguishing between the disease in the child and adult. He believes that in those cases in which the tubercle is found in the substance of the brain it must have commenced in the pia mater.

Tuberculosis of the peritoneum.—Tubercular deposit was found in the peritoneum in eighteen females and nine males. This is

* 'American Journal of Insanity,' Jan., 1862.

nearly 6 per cent. of the total cases examined, and 9½ per cent. of the cases of tuberculosis. Dr. Chambers found tubercle of the peritoneum to exist in 2·3 per cent. of all his cases, and in 9 per cent. of those in which tubercle existed. Of 647 cases of tuberculosis in the adult, Ancell gives only nine as having had tubercular peritoneum, or about 1·3 per cent. Both in the Royal Edinburgh Asylum and St. George's Hospital, it was nearly twice as frequent among the females as the males. In almost all the cases the tubercle was deposited in granular masses, of varying size, according to the stage of the disease. In a few of them it presented the appearance of large, yellow, soft masses, underneath the membrane. In the majority of the cases the tubercular depositions occurred all over the membrane, both visceral and parietal; and when it was limited, the peritoneal coats of the intestines, liver, and spleen, were its most frequent sites. Generally there were adhesions, soft and easily broken down, and frequently a purulent deposit. In all the cases, except one of the females, there was tubercular deposit in other parts of the body, and there were only three of them in which the tubercular deposit elsewhere was not extensive. In three of the cases there was tubercular deposit in the brain as well as in other organs, showing that in them the tendency to tuberculization was so strong that almost every organ was affected.

The following tables exhibit the form of insanity, and the length of time it had existed:

Table V.

	Male.	Female.	Total.
Dementia . . .	3	6	9
Epileptic ditto . .	1	0	1
Melancholia . .	1	6	7
Monomania of suspicion	2	3	5
Mania	2	2	4
General paralysis . .	0	1	1
Totals . . .	9	18	27

Table VI.

Years insane before death	Number of cases.
1	4
2	5
3	6
4	1
5	1
6	2
9	2
11	2
12	2
14	1
15	1
Totals	27

The object of this is to show the large proportion of cases of melancholia and monomania of suspicion—a larger proportion

than exists even among the cases of tuberculosis of other organs, and much larger than among the general population of asylums. This might have been expected from the intimate relationship between melancholia and disorder of the functions of the abdominal organs. It will be seen that more than one half the cases had been under three years insane.

Besides those cases of actual tubercular deposit in the peritoneum, there were among the tubercular five cases of ordinary peritonitis. Louis and Ancell attribute to the peritonitis a tubercular origin in similar cases.

Age.—The ages of the 282 tubercular patients at death are given in the following table:

TABLE VII.

	Male.	Female.	Total.
Between 10 and 20 .	7	4	11
„ 20 „ 30 .	33	23	56
„ 30 „ 40 .	43	45	88
„ 40 „ 50 .	20	36	56
„ 50 „ 60 .	23	18	41
„ 60 „ 70 .	8	14	22
„ 70 „ 80 .	2	6	8
	136	146	282

It will be seen from this that nearly one fourth of the cases were under thirty years of age; whereas I find that not more than one sixth of all the cases, taking the total number of deaths in the asylum, are under thirty. The average age at death was for males forty, and for females forty-two; whereas the average age, taking the whole number of deaths in the asylum since 1857, has been forty-three and a half for men and forty-four and a half for women. The average age at death in those with much tubercular deposit was thirty-seven for the men and forty for the women.

Previous attacks.—In 14·7 per cent. of the men and in 23 per cent. of the women they had had attacks of insanity previous to the one during which they died. Taking the ordinary admissions of the asylum since 1854, there were 18 per cent. of the men who had been insane on previous occasions, and 23 per cent. of the women. Dr. Boyd found that, of 1000 male and as many female patients admitted into the Somerset Asylum, 17·6 of each sex had had previous attacks. The difference between the per-centage of previous attacks among the males who were tubercular and those who were not is so small that nothing can be deduced from it.

Hereditary predisposition.—Van der Kolk thinks that a hereditary predisposition to phthisis may develop into or towards insanity, and *vicè versâ*. There were more than two or three examples among the cases I have examined of a predisposition to both phthisis and insanity in the same individual, and three instances of members of the same family dying of phthisis in the asylum at the same length of time from the commencement of the insanity in each. Two sisters came into the asylum within a year of each other, labouring under the same form of insanity, and both died of phthisis within a year after their admission. The hereditary predisposition to phthisis being seldom inquired into when the patients come into the asylum, anything like its real frequency could not be ascertained.

Some near relatives of the patients, were insane in 28 per cent. of the men and in 25 per cent. of the women who were tubercular, while the per-centage of hereditary predisposition among the admissions since 1840 has been 19 per cent. for both males and females. This may show either that phthisis is most frequent among those with a hereditary tendency to insanity, or that insanity is apt to appear in more than one member of families with a phthisical predisposition.

Those general statistics of tuberculosis among the insane are only the first step of the inquiry we propose to make, however.

The questions that next arise are—How is tuberculosis more common in asylums than among the general population? Is insanity a predisposing cause of tuberculosis? or, do the conditions of life in asylums determine this frequency? or, does the tuberculosis predispose to insanity? Those questions can only be answered by a careful examination of the clinical history of a sufficient number of cases. They are not mere curiosities of vital statistics, for they involve a consideration of the conditions of life among the insane, the etiology of disease among them, and the causes of the insanity itself. They are more complicated questions than most others in medicine, for in addition to the vital forces that govern the bodily functions, to the derangement of which we endeavour to trace diseased structure and disordered action, we have here to deal with psychical and moral causes of disease, operating on individuals of enfeebled constitutions and impaired nervous energy. We shall best arrive at definite conclusions by examining the *facts* in the histories of the cases that show—

1st. The influence of the tuberculosis on the insanity; and—

2nd. The effect of the insanity on the tuberculosis.

The forms of insanity assumed by the 282 cases of tuberculosis are shown in the following table. As the form of insanity changes in most cases, I have given the form of insanity on admission and at death; and as many of the cases had been insane for long periods before their admission into the asylum, I have given the forms of insanity in 103 of them who had been under three months insane before they were admitted. In the latter cases we see the forms first

assumed by the insanity, and the changes that took place before death, and we have therefore their complete history in a tabular form.

TABLE VIII.

	All the cases of tuberculosis examined.						Cases that had been under three months insane before admission.					
	On admission.			At death.			On admission.			At death.		
	Male.	Fem.	Total.	Male.	Fem.	Total.	Male.	Fem.	Total.	Male.	Fem.	Total.
Acute mania	13	21	34	5	7	12	12	18	30	5	4	9
Mania	16	24	40	4	11	15	4	12	16	1	7	8
Monomania	26	28	54	25	14	39	3	9	12	5	6	11
Melancholia	19	32	51	13	16	29	10	17	27	7	11	18
Dementia	36	35	71	61	92	153	3	6	9	13	34	47
General paralysis	26	6	32	28	6	34	8	1	9	9	1	10
Totals	136	146	282	136	146	282	40	63	103	40	63	103
Epileptics	...	...	...	12	5	17	...	...	...	...	...	...

Every form of insanity is thus seen to tend towards dementia before death, but the tendency in mania is twice as strong as in melancholia, and the majority of monomaniacs die unchanged.

In order that a comparison may be made, I have in the following table given the forms of insanity at death of the 181 cases examined, in whom no evidences of tuberculosis were found.

TABLE IX.

	Male.	Female.	Total.
Acute mania . .	11	9	20
Mania	13	6	19
Monomania . . .	13	7	20
Melancholia . .	8	7	15
Dementia . . .	26	23	49
General paralysis . .	56	2	58
Totals . .	127	54	181
Epileptics . . .	9	3	12

Half the tubercular cases were demented, only one fourth of the non-tubercular were so; one tenth of the former died maniacal, one fifth of the latter; one tenth of the former were melancholiacs, only one twelfth of the latter; one seventh of the former were monomaniacs, only

one ninth of the latter; and only one eighth the former were general paralytics, while one third of the latter laboured under this disease. I have associated all the forms of monomania together in those tables, but if one form, viz., monomania of suspicion, be taken separately, a striking difference results. All the females with this form of insanity except one, were found to have tubercular deposit after death, while only six of the males were exempt. General paralysis is the form of insanity most exempt from tuberculosis, and the relations between those two diseases, demands a more careful consideration.

Tuberculosis in General Paralysis.—Since 1851 there have been recorded in the 'Pathological Register' of the Royal Edin. Asylum accounts of the post-mortem appearances in 92 general paralytics, eight of whom were females, and the rest men. In twenty-seven of the males and in six of the females tubercular deposit was found in the lungs. In going over the histories of those thirty-three cases I remarked how constantly they had commenced with melancholia, and how many of them had been suicidal and had refused food at first; but I was scarcely prepared for the result, when at the end I found that in nearly all of them the insanity had commenced with depression. There were seven men and one woman in whom the disease had advanced considerably before their admission into the asylum, whose previous history could not be ascertained; but of the others there were only two males who did not at first exhibit symptoms of melancholia, and the tubercles in those was nearly obsolete. Many of the others were suicidal, and many of them laboured under that deep and intense form of melancholia in which food is refused, while in others the symptoms of depression were not so great. Many of the cases in a subsequent stage of the disease exhibited the excitement and ambitious delusions that more generally characterise general paralysis, but even in those cases they seldom seem to have been so extravagant in their character as they generally are. There are very few examples of the disease to be found where excitement and extravagant delusions are altogether absent in all its stages, and those few will be chiefly found among the phthisical. There are three well-marked cases of general paralysis in which the disease commenced with deep melancholia in the asylum at present, and physical examination demonstrates tubercular deposition in them all.

This intimate relationship between the general paralysis with depression and tuberculosis has never before, so far as I am aware, been pointed out. The number of cases I have adduced are not sufficient to establish a general law that such a connection always exists, but they are sufficiently numerous to show that the one is very frequently related to the other. The tuberculosis was not the effect of the refusal of food or the deranged nutrition that frequently exists in melancholic general paralytics, for in many of the cases there was neither. Many of them, although depressed at first, took their food well, and

appeared to be in good bodily health. In the majority of them the phthisis caused but little inconvenience, and was not even detected till after death. The latency of the pulmonary affection was more marked than in any other form of mental disorder, both from the absence of the usual symptoms, such as cough, expectoration, &c., and from the infrequent occurrence of marked emaciation or feverishness. In this disease, more than in any other, do we see purely vegetative and nutritive functions so independent of all nervous and animal influence, that a man with extensive lung disease may be fat and feverless until the excito-motor centres lose entirely their irritability, the involuntary muscles cease to act, and he ceases to live. It will be said that this results from the stagnation of the pulmonary disease, and that when a man with lung disease becomes affected by general paralysis, the former remains thereafter in *statu quo*, and whatever parts of the lungs are then healthy, remain so, and do the work of respiration. Doubtless this is partly true, but not by any means wholly so. In many of the cases I have referred to, the lung disease was so extensive that it could not have existed before the cerebral mischief without showing well-marked symptoms; and at the autopsies the pulmonary lesions showed distinct indications that they had not been stationary long before death. There are exceptions to the latency of the symptoms of phthisis even in general paralysis, for in five of the cases the tuberculosis was detected during life by the symptoms it produced, viz., cough, hectic, and exhaustion. The average duration of life, after general paralysis has manifested itself, is too short for the development of phthisis from such a cause as want of nourishment. The average duration of life, after the first symptoms of general paralysis had shown themselves in those cases in which there was a large amount of tubercular deposit in the lungs, was two years.* Now as this is not much different from the duration of the disease in ordinary cases, we must conclude that phthisis does not tend much to shorten the lives of the general paralytics in whom it exists; or I should rather be inclined to put it thus: the tendency to death from the cerebral affection is so strong, and certain, and rapid, that the pulmonary affection does little to accelerate it. In fact, the intra-cranial lesion diminishing the excito-mortor irritability of the centres from which the fibres of the pneumogastric nerve arise, deprives the lung lesion of more than half its wasting and exhausting effects. The cough and wakefulness and want of appetite of consumption do not exist.

M. Baillarger has described the depression that precedes and accompanies some cases of general paralysis,† but does not attempt

* Austin gives two years and a half as the average term of life among general paralytics.

† 'Annales Médico-Psycologiques,' 1860.

to explain why this should exist in some cases, and exaltation in others. Austin attributes the symptoms of depression to lesion of the right optic thalamus, but this has been sufficiently disproved by Dr. Skae.* Dr. Skae found that, of 108 cases, 28 were depressed or suspicious. This is nearly the same proportion as the tubercular bear to the whole number of general paralytics examined. Austin gives a somewhat different proportion, for out of 135 cases seen by him there were 57 with melancholic delusions.

Both Austin and Baillarger mention—the latter more particularly dwells on it—that the melancholic delusions of general paralytics are characterised by their extravagance. He says that they imagine they have no stomachs or hearts, that their organs are changed, and that they frequently have hallucinations of smell. Among the cases that have come under my own observation, or whose records I have perused, delusions of this character have not been more frequent than among melancholics generally. The majority of the cases of tubercular general paralytics were characterised by great intensity of depression, frequently of a vague, undefined character, the patient being stupid and confused, with sudden and unaccountable suicidal impulses, and not always with delusions of any kind. In some cases the patients attempted suicide in the coolest possible manner, without manifesting any unusual depression at the time, and evinced no disappointment when their attempts were frustrated. One man told me, when I asked him why he had attempted to hang himself, that it was "for fun." Those who refused food did not do so because they imagined they had no stomach or belly, in any of the cases in the Royal Edin. Asylum. In some cases the depression passed gradually into dementia as the paralytic symptoms advanced, but in fully an equal number there was more or less excitement during some part of the second stage of the disease.

In only one case was there a distinct history of phthisis before the paralytic symptoms commenced; but as, in sixteen of the cases, death occurred within a year of the first manifestation of insanity, it is almost certain that in them the tuberculosis preceded the insanity. It is highly probable that in all of them the tuberculosis had begun before the brain disease; and it is certain that if it had not begun in any of them, the tendency to it must have been very strong. Two such diseases as tuberculosis and general paralysis seldom originate simultaneously in the human body; and as we have seen that the former state did not in many of the cases exhibit its usual symptoms, and did not even produce emaciation, which, whether there are any other signs of it or not, is its most frequent concomitant in other cases, we conclude that the brain lesion must have been engrafted on the other soon after its commencement, obscuring its symptoms

* 'Edin. Med. Journ.' for April, 1860.

and counteracting its effects, although not altogether staying the progress of the local tuberculization.

Taking all the cases of general paralysis in the men, tuberculosis was less frequent than in any other form of insanity. It was present in less than one third of them. Among the women exactly the reverse was the case, three fourths of them all having tubercular deposition; but the number of women being so small, we cannot found any conclusion on the data.

But the influence of the tuberculosis on the insanity is not to be determined accurately merely by ascertaining its frequency in the various forms of insanity. The ordinary classification, although to a certain extent a natural one, is not so complete that we may not have well-marked types of brain disease embracing many cases of each form. We have maniacal melancholic, and demented general paralytics, yet no one would venture to affirm that general paralysis is not a more distinctive and separate form of insanity than either mania or melancholia. Dr. Skae, than whom few physicians have had more experience, or are better qualified to form an opinion on such a matter, considers that every case of insanity comes much more under some natural group than under any of the divisions of Pinel, Esquirol, and Pritchard. I have observed that there are certain cases of which, from their mental symptoms alone, I could predict that they were likely to die of phthisis. They are not all cases of mania, nor of melancholia, nor of monomania, but some of them would come under one of these divisions and some under another. There is no one symptom they have in common, and no well-defined line of demarcation separating them from other cases. There is no diathetic mark or physical sign to distinguish them, yet they take their place in one's mind as a natural group notwithstanding. If they have been acute at first—either acutely maniacal or acutely melancholic—the acute stage is of very short duration, and passes neither into a chronic stage nor into deep dementia, but into an irritable, excitable, sullen, and suspicious state. There is a want of fixity in their mental condition. The intellect is not at first so much obscured as there is a great disinclination to exert it; and there are occasional, unaccountable little attacks of excitement, lasting only a very short time—unprovoked paroxysms of irritability and passion in a subdued form. There is a disinclination to enter into any kind of amusement or continuous work; and if this is overcome, there is no interest manifested in the employment. It might be called a mixture of sub-acute mania and dementia, being sometimes like the one and sometimes like the other. As the case advances the symptoms of dementia come to predominate; but it is seldom of that kind in which the mental faculties are entirely obscured, with no gleam of intelligence or any tendency to excitement. If there is any tendency to periodicity in the symptoms at

all, the remissions are not so regular, nor so complete, nor so long, as in ordinary periodic insanity. If there is depression, it is accompanied with an irritability and the want of any fixed depressing idea or delusion. If there is any single tendency that characterises these cases, it is to be suspicious. I found that, of the 136 men with tuberculosis, 56 manifested suspicious; and 64 of the 146 women did so.* The state I have described may, I think, be called "phthisical mania." The patients are not so apt to get stout as in ordinary dementia, and frequently the appetite is capricious. The pulse is generally weak, and frequently more rapid than usual. There is a want of tone and energy about the system that is very noticeable. There is a want of interest in anything that goes on, and an absence of sympathy where there is not positive suspicion of every one around. In many of the cases the suspicious are the chief symptoms. We have seen that nearly all the cases of pure monomania of suspicion were phthisical. In many of the cases the insanity commenced insidiously, and showed itself by an alteration of conduct and affection, an increased irritability and waywardness, and a progressive weakening of the intellect, without any great excitement or depression. Some cases of the so-called moral insanity die of phthisis very soon. However demented these cases of phthisical mania may seem to be, there are fitful flashes of intelligence; and in them, perhaps more frequently than in any other class of cases, there is increased intelligence, and as it were, a slight unveiling of the mental faculties immediately before death.

Under the term "phthisical mania" I should include only those cases which died within five or six years after becoming insane, and in which the development of the two diseases was somewhat contemporaneous. All the old chronic cases in which the tuberculosis was developed after many years' insanity I should exclude, because in them the tuberculosis might be the result of the conditions of life after becoming insane. All the cases of melancholia with refusal of food I should exclude, because in them we have a cause for the development of tuberculosis apart from the insanity. I found that there were 23 such cases of typical "phthisical mania" among the whole number of men with much tubercular deposit, and 42 among the women. In those 75 cases there were symptoms of phthisis within five years of the commencement of the insanity, and in the majority of them within two years. In those cases (26 per cent. of the tubercular and 16 per cent. of the whole) I regard the insanity to have been a direct result of a strong tubercular diathesis or tendency which was then being developed, or about to be developed, into direct tuberculosis, for the following

* Twenty per cent. of all the cases had hallucinations of the senses, the order of frequency being hearing, seeing, smelling. Hallucinations were twice as frequent among the women as the men.

reasons:—1st. The symptoms of tuberculosis, where they did not precede the insanity as they did in a few cases, appeared so soon after it that, considering their usual latency in insanity, and the known average duration of the disease in the sane, the two disorders must have been developed nearly contemporaneously. 2nd. The insanity was of a type so uniform, so seldom seen in cases which did not die of tuberculosis, all the cases had so much in common, whether there was depression or excitement, and being too numerous to be mere coincidences, the tuberculosis must have been the cause. 3rd. The age at which the insanity was developed in those cases was generally less than the age at which insanity is ordinarily developed, approaching, therefore, more the phthisical than the insane age.

But it will be said that the so-called distinctive and typical cases of phthisical mania form but a small part after all of the phthisical insane. They are not much more than half the cases in which phthisis was the assigned cause of death. What connection has the phthisis with insanity in the other cases? In 21 of the men and in 38 of the women who had much tubercular deposit, the insanity had existed for seven years and upwards before the tuberculosis appeared; and in them therefore the connection must have been either accidental, or some may think the diminished innervation affected the nutritive processes secondarily, and induced the phthisis. The diet of those patients had been quite as good as most of them had been accustomed to, they had plenty of fresh air and out-door exercise, and their clothing had been comfortable, so that the hygienic conditions were favorable.

About 12 men and 30 women had been ordinary cases of acute mania, passing into dementia or chronic mania, with nothing characteristic in the type of the insanity or the advent of the phthisis, and in these therefore we may assume the association of the two diseases to have been accidental.

A suicidal tendency I found to be more common among the tubercular than among the general inmates of the asylum. Twenty-five per cent. of the cases of tuberculosis manifested suicidal tendencies, while the proportion of such cases among the general admissions since 1852 has scarcely been 21 per cent. This is partly accounted for by the greater number of cases of melancholia among the tubercular; but I believe that in the class of deeply melancholic, intensely suicidal patients who refuse food, and in whom this state is chronic, the tuberculosis has a more intimate relationship to the insanity. Such cases generally die of phthisis in no very long time. It is amongst them that we see gangrene of the lung so frequently, and it seems to me that this is only a stronger manifestation of a tendency that exists in those cases to impaired nutrition of the lungs. There were nine men and seven women well-marked examples of this condition among those who died of phthisis, and in one or two

the lungs were partly gangrened and partly tubercular. Gangrene sometimes occurs in those cases in spite of a sufficient quantity of food and stimulants being given. Complete latency of the lung disease, whether it be gangrene or tubercular, is nearly as common in those cases as among general paralytics.

There was a distinct history of phthisis preceding the insanity in eight men and six women. Doubtless there were very many more in whom the lungs were diseased, or beginning to be diseased, before they became insane, for in many of those who died a few months after, there were the evidences of old tubercles. In those fourteen persons the phthisical symptoms had been so long continued and prominent as to be included in the history of their cases. In three or four of them the insanity had been merely a temporary excitement, soon passing off and leaving the patients almost quite well, and therefore very much allied to the delirium of fever or starvation. Morel* mentions this form of insanity as the chief concomitant of phthisis. He says—"From the observation of other writers, as well as from my own experience, I should conclude that if depression usually accompanies the commencement of tuberculization, maniacal paroxysms usually characterise its latter stages. We can to a certain extent explain these phenomena by ascribing them to the disturbance which imperfect respiration occasions in the circulation and nutrition of the brain. In other cases, doubtless, pathological investigation sufficiently proves that the derangement depends on tubercular meningitis in an insidious form." The few cases of this kind compared to the whole number of the tubercular shows how comparatively unimportant they are, and how erroneous an idea Morel's statement gives of the connection between tuberculosis and insanity, by representing that, owing to a temporary and accidental disturbance of the cerebral circulation in the latter stages of consumption, the mental faculties are affected. Tubercular meningitis we have seen to be as rare as this temporary delirium, and not invariably producing any symptoms when present.

Such being the influence of the tuberculosis on the form of the insanity, how does it influence the prognosis? Most unfavorably, we answer. There are very few cases indeed who ever recover their soundness of mind if phthisical symptoms have shown themselves or tubercular deposit has taken place to any extent in the chest after the commencement of the insanity. Some of the few cases do recover in whom the insanity has come on after the phthisis has become chronic, but scarcely any case of "phthisical mania" ever recovers. There may be apparent recoveries, but they are mere slight remissions. This almost universal incurability is a strong argument in favour of my view, that in those cases the insanity is the

* Morel, 'Traité des Maladies Mentales.'

result of the imperfect nutrition of the nervous system in the pre-tubercular, or the beginning of the tubercular stage of tuberculosis.

But it will be said, Why are not all phthisical patients insane, if this be the cause of the insanity in those cases? Some brains have a much stronger tendency to derangement of their functions than others, and it is in them that the impaired nutrition of tuberculosis acts as an exciting cause of insanity. The greater frequency of hereditary predisposition to insanity among the tubercular than among the non-tubercular shows that tuberculosis more than any other cause develops such a predisposition into an actual disease. And in how many ordinary phthisical patients do we find an irritability, lassitude, fancifulness, and fickleness of purpose, that borders on an unhealthy state of mind? It has been my experience that phthisical patients can seldom apply themselves to any continuous mental exertion; but on this point I speak with diffidence. Their intellects may be clear and unclouded to a preternatural degree, but their efforts resemble more the brilliant flashings of an ill-supplied lamp than the continuous steady light of a healthy mind. Ask any one who has watched closely two or three phthisical relatives during their illness, and they will tell you of the absurd fancies, amounting almost to delusions, of the sudden and causeless changes from hope to despondency, from cheerfulness to irritability, of the whims and wanderings of mind, and transitory moments of delirium, that accompanied the disease. All these symptoms have a cause in an ill-nourished brain, and when they are more developed they become insanity. Those four cases of temporary delirium in patients with phthisis which I mentioned as having got quite well in a day or two after coming into the asylum, are the connecting links between phthisical irritability and phthisical mania.

Dr. Sibbald tells me of a case that came under his observation, which I think illustrates very well the connection between an ill-nourished brain and insanity. It was that of a man far advanced in phthisis, much emaciated, and much troubled with cough, hectic, and laryngeal ulceration. He suddenly became subject to the hallucination that he saw a man who always kept his face averted from him, and whom consequently he could not recognise, but who accompanied him wherever he went, walked with him, sat down on the same seat with him, and lay in the bed with him. He felt he was unable to act in any way except as impelled by his strange companion. This was becoming quite unbearable. Dr. Sibbald prescribed an opiate for him to allay the cough, and half an hour after taking the medicine he ceased to have the hallucination. It seemed as if the brain was ill-nourished and ill-supplied with blood, and that the hallucination was the result of its impaired and perverted action. When the opium determined more blood to the

head, the brain resumed something like its healthy functions, and the hallucination ceased.

We shall now address ourselves to the second question, viz., What is the effect of the insanity on the tuberculosis?

The duration of life in the cases of tuberculosis, after they had become insane, is shown in the following table. Let it be observed that this table does not show the duration of life after their admission into the asylum, but from the first commencement of the insanity, except in the few cases in which the duration of the insanity before admission into the asylum is not recorded, when the length of time in the asylum is taken.

Table X.

	Males.	Female.	Total.
Died within 1 year after becoming insane	34	32	66
„ 2 „ „	24	18	42
„ 3 „ „	11	22	33
„ 4 „ „	12	16	28
„ 6 „ „	12	19	31
„ 10 „ „	20	16	36
„ 20 „ „	13	15	28
over 20 „ „	10	8	18
Totals	136	146	282

It is seen from this that exactly one half of all the cases died within the first three years, about one fourth of them dying within the first year. It is extremely improbable that a predisposition to tuberculosis should have been engendered within three years in those cases, and still less likely that a predisposition and a large actual deposit could have taken place during that time. Allowing that, in a certain number of cases, the deposit of the tubercle, and the commencement of the insanity, were mere coincidences, yet it is impossible that this could have happened in one half the number. We have already seen that there were 75 cases in whom the insanity was *sui generis*, and only to be accounted for by the tuberculosis, which manifested itself in them all within five years of their admission into the asylum; but the foregoing table would seem to indicate that in even more than those cases of phthisical mania was the tuberculosis connected directly with the insanity. About two thirds of all the cases of tuberculosis had died before they were six years insane.

Many continental physiologists and pathologists, among whom may be reckoned Van der Kolk, Durand Fardel, Engel of Prague, Schiff, and Brown-Séquard,* attribute much importance, in the

* See Van der Kolk's "Case of Atrophy of Left Hemisphere of Brain," 'Syden. Soc. Trans.,' p. 170.

causation of lung disease, to the morbid influence of the pneumogastric nerve. Guislain* also mentions this among the predisposing causes of phthisis among the insane. That the pneumogastric, when cut, or its ganglia irritated or diseased, may exercise a morbid influence on the lungs, cannot be denied, but I think it is extremely open to doubt, notwithstanding the experiments of Schiff, whether in an otherwise healthy subject any such influence of the pneumogastric could produce tubercular deposition. Few in this country believe that tuberculization is ever the result of such a purely local cause, when there is not also a strong predisposition to it; and even if it were so, there is not the slightest particle of evidence to show that either the pneumogastric or its ganglion, or even the part of the medulla from which its roots arise, is more frequently diseased in those who die of phthisis than in other cases of insanity. The most marked organic changes in the brain are not so frequent among the phthisical as among other insane patients; and we have seen that, in general paralysis, in which the pneumogastric roots are so much involved that in its latter stages the power of swallowing is interfered with and frequently destroyed, phthisis is less common than in any other form of insanity. In epilepsy, too, the seat of which is probably in close proximity to the origin of the pneumogastric, phthisis is not so frequent as in ordinary cases (see Tables VIII and IX), according to the statistics of the Royal Edinburgh Asylum, although Van der Kolk found that "all the epileptic patients who had bitten the tongue died of phthisis, pneumonia, or marasmus," and Brown-Séquard found either tubercular deposit in the lung or pneumonia of the opposite lung from the disease of the medulla in four cases of epilepsy. I have met with one such case of unilateral softening of the medulla oblongata from the pressure of an enlarged odontoid process of the axis; but unfortunately I had no permission to examine any part but the head, so that I cannot speak as to the post-mortem appearances of the lungs. I can certainly affirm, however, that neither pneumonia or phthisis was the cause of death.

If insanity does not tend to produce phthisis by any morbid influence of the pneumogastric nerve, is it not possible that the impaired innervation generally, and the consequent weakening of the circulation, that we find in cases of long-continued insanity, may produce it? We have seen that one third of the patients with tuberculosis lived over six years, one sixth of them over ten years, and about one fifteenth of them over twenty years after the commencement of the insanity. The fact that phthisis is not common in the last and deepest stages of dementia, when the nerve functions are carried on with minimum activity, is not favorable to the idea that the ordinary forms of insanity predispose to tuberculosis. The tendency to tuberculosis which we have seen diminishes rapidly in

* 'Leçons Orales sur les Phrénopathies,' tome i, p. 431.

proportion to the length of the insanity, although partly explained by the rarer occurrence of phthisis as age advances, yet is pretty clear proof that on the whole insanity does not tend to the development of phthisis. The number of cases dying tubercular after being more than ten years insane, compared with the tubercular dying at all ages, is exactly the same proportion as that of those dying non-tubercular after being ten years insane, to the whole number of those who die non-tubercular.

It has long been remarked by all asylum physicians, that phthisis frequently runs its course in the insane without giving any symptoms of its presence, if we except emaciation and weakness; and even emaciation is not always so extreme as to attract special attention. Dr. Workman,* of the Toronto Asylum, has, since I commenced to collect the data for the present paper, published one on latent phthisis among the insane, in which he states his general impressions of its frequency, and goes so far as to attribute the incurability of so many cases of insanity to pathological lesions of the lungs and other organs of the body than the brain. I shall show the extent to which latency of lung disease really prevails, and I think that the brain must be looked on as the organ whose altered function or structure is the cause of so much incurable insanity as we find in all our asylums. I carefully perused the histories of the 213 cases in which there was much tubercular deposit in the lungs, and in 185 of them I have been able to ascertain the time at which the phthisical symptoms first appeared, if such symptoms existed, and the number in which they did not appear at all.

Table XI.

	M.	F.	Total.
Phthisis entirely latent	26	30	56
Symptoms of Phthisis			
appeared less than 1 month before death	6	5	11
,, ,, 3 ,, ,,	9	28	37
,, ,, 6 ,, ,,	17	20	37
,, ,, 1 year ,,	11	14	25
,, ,, 2 ,, ,,	3	5	8
,, ,, 3 ,, ,,	2	4	6
,, ,, 4 ,, ,,	1	0	1
,, 5 ,, ,,	0	1	1
,, ,, 6 ,, ,,	0	1	1
Symptoms appeared . . 9 ,, ,,	0	1	1
,, ,, 35 ,, ,,	0	1	1
Totals	75	110	185

* 'American Journal of Insanity,' July, 1862.

It is thus seen that in one third of the men, and in a little more than one fourth of the women, the tuberculosis manifested itself by no symptom during life. The greater number of men in whom it was latent is accounted for by the greater number of male general paralytics, in whom we have seen that latency is the rule. In about one fourth of all the cases the symptoms of phthisis appeared at periods under three months before death; in one fifth of them the period when they manifested themselves was between three and six months. In only about one tenth of all the cases did symptoms of tuberculosis show themselves more than a year before death. By the symptoms of phthisis I mean cough, expectoration, hectic, and difficulty of breathing. In many of the cases I have put down as latent, phthisis was diagnosed by physical examination. From this table it appears that long-continued phthisis, although exceptional among the insane, yet is not altogether unknown. The two cases, one of whom was markedly phthisical for nine years, and the other for thirty-five years, are examples of this. The average duration of life after phthisis has commenced is calculated by Ancell to be about eighteen months, so that in *nearly all the cases among the insane, phthisis is latent for a certain period.* Among the sane, Louis says that, "out of 123 cases of phthisis, eight (or only one fifteenth) were examples of pulmonary tubercles which were latent, or in other words, which preceded the cough during a period varying from six months to two years." Only four of these preceded the cough, and every other important general symptom; "in the others they gave rise to intense general symptoms, as fever, anorexia, &c., before they excited cough or expectoration."

It is surprising how small is the effect even of advanced lung disease on some of the insane. We constantly see patients going about doing their ordinary work, taking their food pretty well, and looking well, when suddenly their appetite fails, they begin to look haggard and weak, they become more deeply demented and listless, if their pulse is examined, it is found to be almost imperceptible, and in a few days they sink exhausted. After death the lungs are found to be totally disorganized. Old cavities are found that must have existed for months or years. I have seen even more sudden terminations. A man who had been failing somewhat in strength and appetite for a few weeks, and in whom the physical signs of phthisis had been discovered, sat down to dinner as usual, took what appeared to be a fainting fit immediately after dinner, and was dead before I could be sent for. His lungs were found riddled with tubercular cavities. A woman in whom the symptoms of phthisis had shown themselves for a fortnight, went out to walk with her fellow-patients, got weak, and appeared to faint in the grounds, was carried in, and died within an hour. But cases like these, although not uncommon, are extreme; as a general rule the patients show

signs of failing health two or three months, rarely much longer, before the phthisical symptoms appear; they lose flesh, and become more demented, and the periods of irritability and excitement become fewer and shorter, while the suspicions, although still present, are more seldom expressed. In a great many of them, however, the suspicions and obstinacy remain so marked till death, that however weak and exhausted they may be, an examination of the chest is resisted with their remaining strength. Every asylum physician ought to examine the chest of any patient who shows the least sign of failing health and strength, especially if this be accompanied by unusual listlessness and languor.

It must not be supposed, however, that the exhausting cough and the restless, weary nights of hectic and dyspnœa of ordinary phthisical patients are quite unknown in asylums, for although in the majority of the insane the symptoms are either quite latent or modified after they appear, yet in some cases the disease, after its symptoms have once been developed, runs its ordinary course as among the sane. The irritability of the ganglia that regulate the peristaltic motions of the intestines is even lessened, for although ulceration of the intestines exists in the majority of the phthisical insane, diarrhœa is by no means so common, or so troublesome when it exists as in ordinary phthisical patients. I have often seen the whole of the lower part of the ilium and colon one mass of tubercular ulceration, yet there had been no sign of this whatever during life. On the whole, however, diarrhœa is more common among the phthisical insane than either cough or expectoration in the latter stages of the disease.

Almost all writers on insanity, from Mead* downwards, have noticed the occurrence, in some cases, of a kind of metastasis between phthisis and insanity; when the one disease appears the other is abated, or disappears altogether, as if the body had no power to carry on two such diseases at the same time. I believe this is much more apparent than real in those cases. We constantly see a patient who, when free from excitement, is harassed with a cough and spit, and great difficulty of breathing. Immediately he becomes excited those symptoms leave him, and he gets out of bed, walks about, speaks much to his fellow-patients, and appears to be free from any chest complaint, and this may last for a few weeks, till the excitement passes off, when he takes to his bed weaker and much more exhausted than he was before, while the cough returns and goes on more rapidly. Doubtless here the brain excitement masks the phthisis; but it is only masked, and we have no proof whatever that the pathological changes going on in the lungs are stayed in the least degree. In only one small class of cases,

* 'Monita et Precepta Medica.' Dr. Mead.

and exceptionally even in these, is the one disease ever really stayed by the advent of the other, and that is where a short attack of mania occurs in a patient with old, very chronic, slowly-progressing phthisis. In such cases I have seen the patients become stout and healthy during the maniacal attack, while all the phthisical symptoms disappeared. In one such case the improved bodily health remained after the mania had disappeared. I do not believe that insanity is ever relieved or cured by the commencement of phthisis, but think that in all cases where such appears to be the case, the insanity was one of the signs of the pretubercular stage of tuberculosis. True, we often have acute excitement or even deep melancholia disappearing on the commencement of phthisical symptoms, but disappearing only to be followed by dementia and permanent weakening of the mental powers.

The general results to which my investigations have led me are the following:

1. Phthisis pulmonalis is much more frequent, as an *assigned cause of death* among the insane, than among the general population.

2. Tubercular deposition is about twice as frequent in the bodies of those dying insane as in the sane.

3. Phthisis pulmonalis is the "assigned cause of death" in only about one half of those in whom tubercular deposition is found after death.

4. The brain in the cases of tuberculosis is not so frequently diseased in a marked manner as it is in those dying of other diseases among the insane. In the majority of the cases the brain is pale, anæmic, irregularly vascular, with a tendency to softening of the white substance of the fornix and its neighbourhood, and the gray matter of lower specific gravity, than in any other cases of insanity.

5. Tubercle is not more frequently found in the nervous centres among the insane than among the sane, and when found, it does not in all cases, or even in the majority of them, produce any symptoms, and is not connected with any particular form of insanity.

6. Tubercle of the peritoneum is not more frequent among the tubercular insane than among the same class in the sane. In the former it is more frequently associated with melancholia and monomania of suspicion than ordinary tuberculosis of the lungs.

7. The average age at death of the cases of tuberculosis is about three years below the average age at death among the insane generally, and the average age of those in whom *much* tubercular deposit is found is five years below the general average.

8. The proportion of the tubercular who had had previous attacks of insanity is about the same as among the insane generally.

9. There is hereditary predisposition in seven per cent. more of the cases of tuberculosis than of the insane generally.

10. Monomania of suspicion is the form of insanity in which

tuberculosis is most frequent, and general paralysis stands at the other end of the scale that marks the frequency of tuberculosis in the different forms of insanity; mania stands next to general paralysis, and melancholia to monomania of suspicion; while the tendency to dementia, in all forms of insanity, is greater among the tubercular than among the non-tubercular. A majority of the cases of general paralysis and mania die non-tubercular; a majority of the cases of melancholia, monomania, and dementia exhibit proofs of tuberculosis after death.

11. In all the cases of general paralysis who were tubercular the disease had commenced with depression.

12. In a certain number of cases (about one fourth of all those in whom tubercle was found) the insanity is of such a peculiar and fixed type that it may be called "phthisical mania." In all those cases the phthisis is developed so soon after the insanity that tubercles must have already formed in the lungs, or a strong tubercular tendency been present and about to pass into actual tuberculosis when the insanity appeared. We know that the chief characteristic of tuberculosis is an impaired energy in the nutritive processes; and as a badly nourished bone becomes carious or necrosed for slight causes, or a badly nourished skin becomes subject to parasites, so disordered action results in those imperfectly nourished brain-cells from causes which would not be felt by a healthy brain. It is not the enfeebled nutrition directly so much as the perverted action to which the enfeebled nutrition predisposes, that produces the insanity. The peculiar mental state, the incurability of the insanity, the appearance of the brain after death, and its lowered specific gravity, all point to such a cause for the derangement.

13. There is a special relation between deep melancholia with long-continued suicidal tendencies and refusal of food and lung disease—either gangrene or tubercular disorganization.

14. There are a few cases in which the insanity is only a kind of delirium, occurring during previously developed chronic phthisis, and soon passing off.

15. The prognosis is most unfavorable if tuberculosis occurs in any case of insanity.

16. Half the cases of tuberculosis die within three years after the commencement of the insanity.

17. There is no proof that the "morbid influence of the pneumogastric nerve" has anything to do with the tuberculosis in cases of insanity.

18. Long-continued insanity does not tend to the development of tuberculosis more than to the production of other diseases.

19. Phthisis is entirely latent in between one third and one fourth of all the cases among the insane, and in almost all the others it is latent for a considerable time. This latency is most

frequent in general paralysis, in which the majority of the cases of phthisis exhibit no symptoms whatever.

20. There are very few cases where the commencement of insanity benefits the phthisis, but in a few, where the phthisis is very chronic, an attack of insanity may be followed by the permanent disappearance of the phthisical symptoms, or attacks of mania may alternate with symptoms of phthisis. In by far the majority of such cases, however, the phthisical symptoms are merely masked, while the deposition of tubercle goes on.

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ILLUSTRATIONS OF PHTHISICAL INSANITY.

BY

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IN a paper which appeared in this Journal for April 1863, on "Tuberculosis and Insanity," I described a form of insanity which had appeared to me to be sufficiently distinctive in its symptoms to rank as an order in any classification of insanity that was based on causes, and sufficiently often associated with tubercular deposition to warrant its being called "Phthisical." "Phthisical *Mania*," the name I ventured to give it, may have been an unfortunate one, in that it appeared to make it merely a form of the division *Mania*, whereas I meant it to describe a form of insanity as distinct as *Mania* itself. "Phthisical Insanity" would have been a more appropriate term, and by that name I shall speak of it in the remarks which follow.

As an appendix to that paper, I had proposed to give a few typical cases out of those that had come under my own observation, illustrating phthisical insanity; but the limits of the space at my disposal prevented me from doing so at that time. But I have since then found so many illustrations of the truth of all I said about phthisical insanity, that I think the histories of a few cases, along with a short commentary on each, may help to confirm the truth of my former conclusions, and to direct the attention of the profession to the subject.

To my description of "phthisical insanity," as given at p. 36 in the number of the Journal referred to, I have now nothing to add, nor have I any reason to correct or alter in any way the account of the disease as there laid down. It is difficult to recapitulate shortly

the chief symptoms of phthisical insanity; but suspicion, irritability, want of fixity of mental condition, want of regular periodicity, unsociableness, disinclination to exert the mind and body rather than inability to do so, want of tone and energy in the system, rather weak bodily health, and the absence of any acute symptoms, may be said to be the most common characteristics.

In answer to those who say that they have not found any such special form of insanity connected with tuberculosis, I can only say that their experience has been different from mine and from that of others who have abundantly confirmed mine in this matter; and in answer to those who say that even if such cases of insanity do exist very commonly where phthisis is present, yet they are ordinary cases of insanity which take this form from the general weakness of the system induced by the tubercular deposition—to this I can only answer that such cases of insanity assume that form from their commencement, and often long before tubercles can be detected. Others of my critics have said that in those cases, neither disease can be said to be specially dependent on the other, as both are the result of the tubercular diathesis, and it is merely accidental that one disease is developed before the other. No doubt both diseases may be manifestations of hereditary defect; but it would seem to be more accurate to say that the defects of constitution that predispose to insanity and tuberculosis are perfectly distinct, but so far allied that among the tubercular or those in the pretubercular stage, insanity is very apt to make its appearance. We know so little what the tubercular diathesis or the tendency to insanity means, that it would merely be useless speculation to discuss whether they are identical or allied, or to take up our time in saying much about them. All we can do at present is to note the statistics of the two diseases, to observe how they influence each other, and try to form conclusions therefrom. The following cases may assist in showing how they influence each other when they occur together:

Case 1.—M. M—, æt. 43. The history of this case was not known very accurately, but this seems to have been the first attack of insanity, and it had not existed more than a few months. She resided in London, and came to Edinburgh to seek her son, who had been dead some time. This she had known before she became insane. No hereditary predisposition was known. She had been wandering about and troublesome, but not violent.

On admission, she was apathetic, and when roused, suspicious-looking, not answering questions correctly or even intelligently; but showing her insanity much more by her peculiar expression of face, and her conduct when spoken to, than by her conversation. Hair dark, complexion dark. She seems to have been always of a melancholic temperament. She was thin and weak, but appeared before becoming insane to have enjoyed good bodily health on the whole.

After being some time in the asylum her mental state was the following:

"She has many delusions, which she only shows at times, and is not very

consistent in her expression of them. She fancies that she is pregnant, that the fœtus is extra-uterine, and that she will require to be operated upon. She is very suspicious, and especially of her food, sometimes starving herself in case of being poisoned. She also, at times, seems to imagine that she has much property that is being kept away from her. She is very idle, cannot by any means be persuaded or compelled to employ herself. At times, without any cause, she becomes abusive to those about her and much excited. She remains thin and pale, but takes her food well, and has shown no symptoms of suffering from any disease. She is unsociable, takes no interest in her friends, does not want to get away from the asylum, or, at least, expresses no wish to do so. She gets excited for short periods of a few hours at times, and during these attacks of excitement all her symptoms are much worse."

And in the course of two years her state was the following:

"She is now much thinner and weaker than she was, but no symptoms of any disease have manifested themselves, and she refuses to have any examination made of her chest. She is more taciturn and less seldom abusive, except when she is spoken to or interfered with. She never speaks to any one except to ask for anything she wants, resents being interfered with in any way, and treats all about her as if they were her enemies. When asked about her health she frequently becomes abusive, and seems to think some insult or harm is meant her. She is never pleasant by any possibility, and never thankful for any attention shown her. She distinguishes by no signs those who are kind to her from those with whom she has nothing to do. At long intervals now she becomes excited, abusive to some one who has given no cause for such conduct, and she gives no cause for such abuse."

She remained mentally as described, but in bodily health became weaker, lost flesh, and did not take her food so well, but no cough nor spit appeared till two months before her death, which occurred after she had been in the asylum five years. For two or three years before death she had been thin, pale, weak, capricious in her appetite, inclined to keep her bed, and evidently labouring under organic disease. She resisted an examination of her chest so very strongly that it was never made. There was never any diarrhœa, but all the other symptoms of phthisis were present in great severity for two months before death.

Post-mortem examination.—The brain was atrophied, anæmic, and œdematous. The white substance composing and surrounding the fornix and septum lucidum was almost diffluent. The left lung was everywhere infiltrated with masses of tubercle, each tubercular spot soft in the centre. The cavities so formed were many of them very old evidently. The upper lobe of the right lung was in this condition also. The mesenteric glands were enlarged and tubercular. The mucous membrane of the cæcum and ascending colon was ulcerated, thickened, and red.

Commentary on such a case is almost superfluous after what I have said in my former paper about phthisical insanity. A woman has a family, and lives till she is forty-three. She then becomes insane, never having very acute symptoms, but *suspicion, irritability,* with causeless, unaccountable exacerbations, and a *want of interest in anything,* being the chief symptoms. She is thin and in weak bodily health when she becomes insane, and although getting good food and fresh air, never gets stronger. She gets weaker, and paler, and thinner gradually, until she is exhausted and very weak;

and then a severe cough and spit comes on two months before she dies. Can any one doubt that in this case the insanity was almost contemporaneous in its appearance with the development of tuberculosis?—that the ordinary symptoms of the latter disease were obscured by the state of the brain?—and that it was the tuberculosis, and not the insanity, that kept the patient thin and weak bodily? And do not the mental symptoms resemble in some degree those of an exhausted man whose brain has been starved of a sufficient supply of nourishment by a disabled stomach, an exhausting discharge, or unsound lungs? I have selected this case, where *no* examinationof the chest was at any time made, in order that the similarity in all points between such unexamined cases and others which were examined, and the date of the deposition of the tubercle in them determined, may appear. The majority of such cases are apt to go on without any examination of the chest for a long time; but if their subsequent symptoms agree in all points with those of the cases where tubercle was early discovered in the lungs, surely it is no unwarrantable inference that if the tubercle had been looked for earlier in those cases it would have been found. The state of the lungs in this case showed conclusively that they had been the seat of tubercular deposit for a long time, for years at least, before the ordinary symptoms of phthisis appeared.

Case 2.—H. S—, æt. 20, a map-colourer, of ordinary education, cheerful disposition, steady and industrious habits. She had been subject to "fainting fits," but otherwise had been in good health. She had been engaged to be married to a respectable young man, but shortly before the commencement of her illness—or rather, perhaps, at the commencement of her illness—she began to entertain fears that he was not a Christian, and she came to the conclusion that in those circumstances it was her duty to postpone her marriage. She then became melancholy, took a gloomy view of everything, and proposed going as a missionary to the Indians. She then began to fancy her food was poisoned, became irritable and dangerous to her relations when in a passion. She was sleepless and her appetite was diminished, and she was sent to the asylum.

On admission, she was excited, her eyes were very bright, her countenance animated and expressive; she talked freely; she did not express much surprise or astonishment at finding herself in an asylum. She evidently, though apparently pretty rational, did not appreciate her position. She had dark hair, beautiful dark eyes, and delicate, refined features. Phthisical symptoms and physical signs were well marked.

At first she became very melancholy at her catamenial periods, but under the influences of fresh air, good food, and quiet, she became apparently well and was removed from the asylum. Her phthisical symptoms abated also. But in a very short time she was brought back to the asylum with all her symptoms aggravated. She was more suspicious, and more incoherent when excited. She was very listless and weak, suffered from cough, night sweats, expectoration, and pain, when free from excitement. But when she became excited she got out of bed, dressed herself, walked about the ward, never coughed, never spat, talked almost constantly, imagined herself a person of

importance, or hinted her suspicions in a vague way to those about her. Her pulse was quicker when excited, however, than when free from excitement. Those attacks came on irregularly till, in six months, she died. Her appetite was better during her excitement, but she did not sleep then. When free from excitement she sometimes was quite rational but listless, and was so before she died. Both lungs were completely disorganized.

This was a very characteristic case of *acute* phthisical insanity. The suspicion, listlessness, and disinclination to exert the mind or body when free from excitement, the latency of all the lung symptoms when she was excited, the obvious advance of the disease during the excitement as well as during the quiet periods, but the insensibility of the cerebral excito-motor centre at the former times to the irritation of the disease of the lungs, were all very characteristic of such cases. They are more common in the young; the slower, more demented cases are more frequent among those further advanced in age.

Case 3.—J. R—, æt. 31, a joiner. Father had been insane. Had led a dissipated life at times. Had always made his living at his trade. Was married, and had a family. The first symptoms of insanity were noticed more than a year ago, and he was then sent to an asylum, but having apparently quite recovered, he was discharged. He was never quite well after this, however. He was unsettled, would not work at his trade with any one master for more than a few weeks at a time. He accused his wife of poisoning him, of conspiring against him, and of getting her relations also to plot against his life. His having been in an asylum at all he attributed entirely to their desire to get rid of him for their own purposes.

On admission into the asylum, he was quiet, reserved, and suspicious in look and manner, without showing much suspicion in his words generally. He was a man in average health, with a fair complexion, dark-brown hair, and a more than usually intelligent face. He was very reticent about his delusions.

For some time after admission he wrought in the joiners' shop, but then began to fancy that his working there kept him in the asylum, and refused to work any longer. He became more unreserved in his expressions of dislike and suspicion of his wife and her relations. He might often be seen to exchange his own dish for that of his next neighbour at meals, when he could do so without attracting much attention. He looked as if he "knew all about it" when asked about this proceeding, but could give no explanation of it. He evidently had strong prejudices against the head male attendant, and shook his head and laughed, and said, "You know very well," when asked why he disliked this man. At one time he became so well that his discharge from the asylum was contemplated.

He had not been in the asylum six months till he had slight hæmoptysis, and when his chest was examined thereafter the presence of tubercular disease was indicated by dulness on percussion, and crepitation on auscultation at the apices of both lungs. He said, however, that he had often, before he came into the asylum, spat blood. Shortly afterwards his state was the following:—

"He now works in the joiner's shop only when he is almost obliged to do so. He often requires to be told that he will be carried out if he will not walk. He is not asked to work hard, and is only asked to work at all for his own sake, because when he is employed in any way he is much happier

and more content than when quite idle. He sometimes abuses the head attendant in most unmeasured language. He imagines he is the heir to large estates, and is kept here a prisoner by his wife's relations to exclude him from his inheritance. No amount of persuasion will convince him that this is not the case. He is suspicious of almost every one round him; he tries to exchange the portion put before him at every meal for that of some one else. He is at times very irritable, and gets much excited. He took cod-liver oil for some days, but then imagined it was poisoned, and refused to take it on any account. He is constantly asking for changes of diet, and when he gets them he remains as dissatisfied as before. He is still pretty strong, and is in good condition; but complains when at work of shortness of breath. It is not for this that he refuses to work, however; he imagines that it will be the means of keeping him longer here. His most common question to the reporter every day is, "When will this have an end?" referring to the conspiracy which he imagines is being formed against him. At times he is entirely reticent, merely shaking his head significantly when asked how he is—"Oh, you know well enough, why ask me?"

A year after admission he was attacked with a cough, and spit, and his difficulty of breathing became increased and he was no longer asked to do any work. He got much worse mentally immediately after he was allowed to be quite idle. He could never be induced to take any kind of medicine for more than a day or two, and the extra diet and stimulants ordered for him were almost forced down his throat. His lung disease was evidently advancing rapidly. He became worse every week, while his suspicions and irritability became the cause of more and more misery to him. He gasped reproaches against the medical officer as he sat coughing and breathless, for giving him the medicines intended to relieve him. Everything that was done for him he imagined to be for a sinister purpose, every one who was kind to him he suspected of being an enemy, and all the symptoms of his disease he believed to be caused by his food or medicine. All his symptoms were as severe, when they once had fairly commenced, as in ordinary cases of phthisis among the sane.

To the last he retained his suspicions unchanged. He died within eighteen months from the time of his admission. He was much exhausted, but not quite emaciated when he died.

Post-mortem examination.—The brain was on the whole almost normal, except that the arachnoid was very milky, and the pia mater infiltrated with opaque serum, while the lining membranes of the ventricles were thickened and, in the anterior part of the lateral ventricles, covered with small granulations.

The lungs were both almost entirely infiltrated with tubercle. This tubercle was very hard, however, except in some softened spots. It was intermixed with the fibrous pneumonic lung, and, as was seen from the appearance of some of the vomicæ, as well as the consolidated fibrous lung, had been deposited there for a long time. The cavities and the densest parts of the tubercular deposit in both lungs were at the bases. There was no ulceration of the cæcum or colon. The mucous membrane of the stomach and duodenum was of a very dark colour and very soft.

This is a good example of those cases of pure monomania of suspicion, almost all of whom, according to my statistics, die of tuberculosis. The insanity was strongly hereditary. In this case some of the exciting causes of phthisis had been present. He had led a fast, irregular life. The suspicions about his being an heir, and

about being kept in the asylum by a *conspiracy* against him, are very characteristic of such cases. So, too, was the usual reticence about those delusions, the actions and expression, rather than the words, indicating suspicion, with the violent outbursts at times, when all the pent-up thoughts would find expression, and the want of self-control of the insane man be exhibited. And in this case, too, there was the usual aggravation of the mental symptoms, when the bodily disease was being developed more than usually rapidly; and lastly, the most painful symptom of all, the utter want of sympathy with any one about him, the suspicion of every one and everything, the inability to see or understand kindness of any kind, and the suspicions being most directed against the relatives. In such cases the functions of the brain are less impaired than in any other form of insanity with tuberculosis, and hence the latency of the symptoms of phthisis is least marked, if indeed there is latency in those cases at all.

Case 4.—J— M—, æt. 25, domestic servant, with no hereditary predisposition to insanity. Had for many months laboured under consumption. Had never been insane; was in a weak, exhausted condition when she first showed signs of mental aberration. In a few days she became violently excited, sleepless at night, utterly incoherent in conversation, and destructive to windows, furniture, and linen. She was in a very fevered state during all this time. In the infirmary, where she had been sent before arrangements could be made for her admission into the asylum, she became more quiet and rational. On admission she was confused, weak, and slightly incoherent in conversation. She had some delusions about her treatment in the infirmary, and her mind was especially disordered on religious matters.

A good diet, wine, fresh air, change of scene, and quiet, seemed to have a very beneficial effect on the mental disorder, and also to improve her bodily health for the first month after admission. At the end of that time there only remained an inactivity and apathy of mind, a capriciousness in her likings and dislikings, and a slight tendency to be morbidly suspicious. She spat much purulent matter, but coughed little, thus indicating the diminished sensibility of the excito-motor nervous centres so universal in the insane. She gradually sank, from the advance of the lung disease, her mental apathy becoming greater as she got weaker, but she had no return of the maniacal symptoms, nor any other form of marked mental derangement.

On a post-mortem examination the lungs were found to be tubercular throughout, but the deposit was in two very different states. In the upper lobes it was infiltrated, and disorganized into cavities; in the lower lobes it was in the form of miliary tubercle, with the intervening lung tissue crepitant. At some places those miliary deposits were so abundant that they ran into each other, and formed a solid mass. The mesenteric glands were large and tubercular, and the cæcum and Peyer's patches ulcerated.

In this case I think the insanity had been developed at the time those miliary tubercles were deposited. They were evidently much more recently deposited than the tubercle in the upper lobes. The deposits and the disorganization of the tubercle in the upper lobes had been gradual and steady, but at a particular time the tendency

to tuberculization had evidently become very much greater, increasing the fever, and upsetting the healthy action of the already ill-nourished brain.

I have selected these four cases as representing the four most common forms of phthisical insanity. The first two are the most typical, the one being a chronic and the other a more acute form; the last two represent forms of phthisical insanity, connecting it with insanity from other causes. The first connects it with ordinary cases of monomania, and the last with ordinary cases of acute mania. In J— R—'s case the functions of the brain generally, were least interfered with by the tuberculosis; in J— M—'s case they were most interfered with, but the disturbance was of short duration, and much more allied to the disturbance of the cerebral functions in the delirium of fevers and inflammation than any other form of insanity.

I have lately had two cases in which disease of the cartilages of the knee and ankle-joints respectively has taken the place of the lung disease, or rather has been engrafted on it. The deposit of tubercle in the chest was stopped in both cases, and the vicarious affection of the joints and bones seemed rather to improve the mental state in both cases.

Case 5.—J— M—, æt. 48. Had been insane for six months. This was his third attack. Had been incoherent in conversation, violent in conduct, and jealous of his wife.

On admission he laboured under many delusions, but these were stated somewhat incoherently. He fancied the house belonged to him; said he was God; thought Queen Victoria had robbed him. He was a spare man, of about the middle height, with dark hair and a dark complexion.

For the first year and a half of his residence in the asylum he was at times excited, violent, and dangerous, and at times quiet and useful. He evidently deemed himself as holding some office in the institution, and was very careful of the furniture and attentive to the sick patients. He remained very incoherent in long conversations, mistaking the identity of many people around him, and yet in casual, ordinary remarks, did not show any incoherence. He remained in good bodily health apparently, taking his food well, looking very well, and showing no symptoms of any bodily disease whatever.

About a year and a half after admission his left knee-joint became the seat of what appeared to be at first ordinary synovitis. But, in time, abscesses formed round the knee-joint, not at first communicating with it, and rather obscuring the chief seat of disease. The small joint between the head of the fibula and the tibia was the first place where ulceration of the cartilage began, judging from the pain and swelling, and the formation of an abscess around it. The disease was very chronic, and often showed temporary signs of amendment, which, along with the fear that an operation would not prolong his life for any very long time, prevented the leg from being taken off. From the time of the commencement of the disease of the joint, the patient had been cachectic in his appearance, and had been taking cod-liver oil, quinine, iron, wine, and extra diet. He died ten months after the commencement of the local disease. During all the time the latter

existed he was more rational, mentally, than he had been before in the asylum, though far from being perfectly well in that respect.

After death his right lung was found very tubercular in its upper lobe, the tubercle having evidently been deposited for a long time; it had been slowly ulcerating, and breaking down at some parts. The cartilages of the knee-joint affected had disappeared, and the ligaments almost entirely ulcerated away, the ends of the three bones being rough, exposed, and bare. The marked disease of the ligaments accounted for a very strong tendency to dislocation of the tibia backwards posterior to the condyles of the femur.

Case 6.—J— W—, æt. 23; has been insane for about six months; parents in poor circumstances. Had two sisters, who died of consumption; was himself a weakly child, and had been pronounced by the doctor in attendance on him in childhood likely to die from the same disease. In appearance, form, and complexion, he was like the two consumptive members of the family, and unlike the others. He had been in somewhat delicate health during his adolescence, but had shown no positive signs of disease of any kind. His insanity commenced gradually; he became melancholy, listless, and absent-minded; he then became restless at nights, peculiar in his temper, and irritable; especially he was so at times, the periods of exacerbation being irregular and quite unaccountable. He quarrelled with his father and struck him in one of his periods of excitement, and this was the cause of his being sent to the county gaol, and thence to the asylum. No hereditary predisposition to insanity in the family.

On admission he was mentally composed, absent-minded, and restless; he made faces, and put himself into curious attitudes; he answered questions half a minute after they were asked, and then hurriedly, as if he was thinking of something else. He seemed in good bodily health, though thin, and very pale. He had a fair complexion, and light hair, and was very tall and overgrown-looking.

He remained in much the same state as on admission for some time; he was obstinate and destructive, and could not be got to employ himself. He then became worse, going about undressing himself, fighting, swearing, and refusing to do anything he was told, while he gave the impression to the attendants that this was entirely through obstinacy and wilful ill-behaviour. He remained for several months better and worse, in that way. When fairly roused and his attention fixed, he could answer intelligently questions put to him even when in his worst states; and when he swore, and used abusive language, he did so in a *rational* way, if I may be permitted to use the word as describing the impression his manner would have made on a non-professional person seeing him in this state. All this time his state of bodily health depended apparently on his mental condition, but I believe the reverse was the case, and that when he got thin and weak-looking, he became worse mentally. When, by means of a liberal allowance of stimulants, cod-liver oil, and extra diet, he recovered in some degree his bodily strength, his mental symptoms showed signs of improvement. Phthisis was suspected, but beyond prolonged expiration at the apices of the lungs, there were no physical signs of tubercular deposition.

After being seven months in the asylum he refused his food for three weeks, assigning no reason, looking composed and absent-minded, resisting much when fed, and losing flesh rapidly, notwithstanding his having an abundant quantity of strong beef-tea, custard, and wine, administered to him. He appeared to suspect poison. At this time the physical signs of tubercular deposition became evident, but there was no cough or spit, and no complaint on his part. After refusing food for nearly a month he began to take it

again with much difficulty, and required much pressure. A fortnight after he began to take his food his right ankle began to become red, and painful, and weak. He was confined to bed, but the inflammation of the ankle-joint increased. His mental symptoms became much better as his ankle got worse. The joint became weak and a little swollen, and he began to answer questions more quickly and rationally. The joint became quite unable to support his weight, got weaker, more red, and gave signs of there being pus outside of it. At the same time he assumed a more sane expression of face, and appeared to get almost well, mentally. The crepitation and other signs of *active* tubercular deposition in the lungs also ceased; his appetite increased until it became enormous, while he actually gained in flesh and strength, notwithstanding the discharge of pus from the ankle. It was now evident the cartilages of the joint were much affected, for the bones grated on each other when the joint was moved. An abscess then formed over the shoulder-joint, and discharged a large quantity of matter, but it could not be ascertained whether it communicated with the shoulder-joint. The parts about it are very much thickened and swollen. In this state the patient remains at present.

These two cases, if we admit that in them the tubercular deposition in the lungs and the disease of the joints were equally the result of the same diathesis—and few surgeons would deny it—if we admit this, they would show that—

1st. Tuberculosis, as disease of the joints, may be connected with insanity, and may occur in the peculiar form of insanity I have called "phthisical" (J— W—'s case), taking the place of the lung disease.

2nd. Active disease of the joints occurring in tubercular subjects may not only cause a remission of the symptoms of phthisis, but may also cause a remission of the symptoms of insanity.

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OBSERVATIONS

ON THE

TEMPERATURE OF THE BODY IN THE INSANE,

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WHEN I was engaged a short time ago in trying to determine accurately the effects of certain medicines on maniacal and epileptic patients, the temperature of the body in those patients was one of the things noted by me; and being unable to find in any book the normal standard in the insane, I made and analysed 2000 observations of temperature, so that I might have a standard with which to compare my cases. I examined and noted the temperature of all the patients in this asylum, using the thermometer recommended by Dr. Aitken. I took the temperature in the axilla, and my object being a practical one, instead of examining the patients at the times when the maximum and minimum heat is usually found, viz., immediately after waking, and at midnight, I did so between ten and 12 o'clock in the morning, and between nine and ten o'clock at night. The patients here all get up at 6.15 a.m., and go to bed at 8 p.m. Perhaps those hours will, on the whole, be found more useful and convenient than any others for the medical officers of most asylums, if any of them should ever refer to those observations for a standard of insane temperature. In my preliminary observations, I

found that to get the temperature of the body in the insane perfectly accurate, the thermometer had to be kept in the axilla in many cases for seven or eight minutes, the time varying exceedingly in different cases, but that in most cases the mercury had risen nearly to its maximum at the end of four minutes. Knowing that the general use of such an instrument in the wards of an asylum must depend chiefly on the facility and speed with which it can be used, and wishing to produce a useful standard rather than an absolutely accurate one, I fixed on four minutes as the time during which to leave the instrument in the axilla in every case. The observations were made in the winter months.

I am aware that the numbers examined, especially in the case of some of the forms of insanity, are too small to give a correct average, but they were all I had the means of observing, and even in the case of those forms of insanity of which there are fewest patients in this asylum, there is always a "fair selection" of cases. The results may serve to indicate the direction of the truth, if they are not quite conclusive.

I took the temperatures of 305 patients in all, making two observations each day a patient was examined—one in the morning, another in the evening. On the days in which I was from home, or otherwise engaged, the temperatures were taken by my assistant, Dr. Campbell, but the great majority I took myself. Some of the patients I examined as many as thirty-five times within a period of five months. Such were usually excited patients, or those passing from one state into another, general paralytics, epileptics, and phthisical patients. Only by such frequent examinations can a good average be got in such cases.

In many patients taking the temperatures was a most formidable business indeed. Many of the maniacal patients resisted most violently, and had to be held by force while it was being done. The destruction of thermometers has been considerable. The uses and effects of putting the instrument under the arm were the subject of many and strange speculations among the patients. The favourite theory among the women was that I was finding out the amount of ill-temper in each of them, and many a sly inuendo was put forth as to the quantity that would be found in certain of the touchy and irascible. Great anxiety was usually manifested to know at the conclusion if there was much ill-temper found.

On the other hand many terrible effects were attributed to the harmless bit of glass. It sucked the blood out of some, and the spirit out of others; it made some cold in that side for days, and others hot as long; while in one happy case it killed some rats which had been feasting on the woman's entrails for years!

In examining the patients, I soon found that while there was considerable difference between patients labouring under different forms of insanity, there were also great differences between patients who laboured under the same form of insanity. I found some demented patients to have a high temperature, and others a low temperature; some general paralytics to be high, and others to be low. Certain cases I found to be above the limits of the healthy state, and I shall afterwards refer to these separately. But in the majority of the patients it was evident that all the cases of the various forms of insanity would have to be added together, and the average temperature taken, in order to get an accurate result; and that this result would have a physiological and pathological rather than a clinical value, showing the upward or downward tendencies of the vital force, or the presence of latent but fatal disease in each *class*, rather than giving indications for treatment in each *case*. When acute disease of any kind is present in the insane the thermometer is a most useful, and in some cases indispensable, aid to diagnosis.

In Table I. I have given the results of all the observations I made. I first ascertained the average temperature of each case, and this was used in ascertaining the averages of the different forms of insanity. Instead of taking the usual standard of sane temperature at 98.4°, I examined all the officers attendants and servants employed in the asylum at the same time in the morning as I had examined the patients, and again at night after they had been in bed from one to two hours, as in the case of the patients. I cannot explain the difference between my results and those of Dr. Davy, except that his were scientifically accurate, while mine were only practically so, and that all my observations were made in winter, at a lower temperature of the air than his, and at different times of the day. All the persons so examined were living in pretty much the same hygienic conditions as the patients.

It is seen from this table that the mean temperature is highest in general paralysis (98°), gradually falling in acute mania (97.6°) (the acute and chronic mania includes all the patients who were labouring under attacks of excitement at

TABLE I.

Form of Insanity.	No. of cases examined.			Morning Temperature			Evening Temperature.			Mean Temperature.			Difference between Morning and Evening.			Per centage of the cases in which Evening Temperatures were higher than Morning Temperatures.
	M.	F.	T.	M.	F.	T.	M.	F.	T.	M.	F.	T.	M.	F.	T.	
				deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	
Acute and Chronic Mania	7	21	28	97·44	97·73	97·66	97·25	97·65	97·55	97·34	97·69	97·6	·19	·08	·11	41 per cent.
Mania	46	45	91	97·2	97·2	97·21	97·1	97	97·07	97·16	97·1	97·13	·1	·2	·14	38 ,,
Melancholia	9	8	17	97·33	97·46	97·39	97·22	96·8	97·03	97·27	97·13	97·21	·11	·66	·36	31 ,,
Dementia (mild)	30	14	44	97·23	97·5	97·32	96·79	96·79	96·79	97	97·15	97·05	·44	·71	·53	35 ,,
Dementia (complete) ...	24	21	45	97	96·88	96·96	97·04	96·97	97	97·03	96·92	96·98	·04	·09	·04	9 ,,
Epilepsy	29	9	38	97·48	97·62	97·52	97·38	97·12	97·32	97·43	97·38	97·42	·1	·5	·2	39 ,,
General Paralysis	14	...	14	97·37	...	...	98·	...	...	98·	...	...	·7	...	...	100 ,,
Phthisical	5	4	9	97·69	99·16	98·35	97·95	99·39	98·59	97·82	99·28	98·47	·26	·27	·42	56 ,,
Convalescent	11	8	19	97·23	97·57	97·37	96·84	97·3	97·02	97·03	97·43	97·2	·39	·27	·35	31 ,,
Totals and Averages	175	130	305	97·3	97·32	97·31	97·21	97·17	97·19	97·25	97·25	97 25	·09	·15	·12	41 ,,
Sane persons in good health	19	21	40	97·47	97·52	97·5	96·47	96·9	96·7	96·97	97·21	97·09	1	·62	·8	27 ,,

the time of examination), epilepsy, (97.42°); melancholia, (97.21°); convalescence, (97.2°); mania, (97.13°); and mild dementia,)97.05°;) until we reach the lowest temperature of all in complete dementia, (96.98°). But when we examine the actual decrease we find that after all complete dementia is only 1.02° below general paralysis; and that the latter is only .91° above the temperature of the 40 sane persons examined, while the former is only .11° below it. There were nine patients in the house who had phthisis pulmonalis, and their average temperature was highest of all, being 98.47°. The mean temperature of all the patients examined was 97.25°, which is .14° above the healthy standard. Every form of insanity, except dementia, was above the healthy standard.

Differences between the Morning and Evening Temperature. —A very remarkable difference is noticed between the morning and evening temperatures in some of the forms of insanity, as compared with others, and between all the forms of insanity, as compared with sanity. In the healthy the average evening temperature was .8° lower than the morning temperature, and this agrees very nearly with what Dr. Davy says has been found to be the difference in temperate climates (.82°). In mild dementia the difference is seen to be only .53°; in melancholia it falls to .36°; in epilepsy to .2°; in mania to .14°; in acute excitement to .11°; in complete dementia the evening begins to be higher than the morning temperature by .04°; in the phthisical this difference mounts up to .24°; and in general paralysis we find that the difference is .77°, being nearly as great on the side of the evening temperature as we find in health on the side of the morning temperature.

This is a striking fact, when we consider that in acute fevers, and indeed in nearly all bodily disorders, a rise in the evening temperature is always looked on as a bad sign. It is a sign of *progressive disease* in fact, and when we look at the sequence of the forms of insanity, when arranged according to their differences of morning and evening temperature, beginning with that in which it is nearest to the healthy state, we have an exact scale of the death rate among the insane. Mild dementia is unquestionably the form of insanity most like sanity, both in its psychical characteristics and in its freedom from an active tendency to death; while general paralysis, at the other end of the scale, is the most fatal by far.

An examination of the temperatures of the individual cases of general paralysis shows a still more striking fact in reference to the increase of the evening temperature. (See table II.)

TABLE II.

	Average Temperature.	
	Morning.	Evening
	Degrees.	Degrees.
D. M. (end of 1st stage—excited) ...	98.01	98.14
J W. (1st stage—slightly excited) ...	96.4	97.2
W. B (end of 1st stage)	97.15	98.16
F. L. (1st stage—quiet, rational)	96.5	97.52
M. B. (end of 1st stage)	97.84	98.
H. P. (1st stage—a little excited) ...	97.5	98.42
T. T. (2nd stage)	97.18	97.5
J. W. (2nd stage)	96.44	97.05
R. T. (2nd stage)	96.4	96.56
W. L. (2nd stage—depressed)	95.14	96.38
A. K. (2nd stage)	97.2	98.2
J. C. (3rd stage)	98.5	100.7
G. R. (3rd stage)	99 6	99.9
G. E. (3rd stage – moribund)	102.5	103.5
	97.6	98.37
Mean temperature	98.	

Among those fourteen general paralytics there are patients in every stage of the disease, from the beginning of the first, when there seems scarcely anything wrong at all with the patient, to the end of the last stage, when death is daily expected. Some of them have passed from one stage of the disease into another while the observations were being made on them, and the average temperature of each was determined by ten observations.

In every case, without exception, the evening temperature is higher than the morning. This affords a most valuable indication in the diagnosis of doubtful cases of the disease. What would the physician not give sometimes to be able to pronounce certainly that a case is *not* one of hopeless brain disease? And how much mischief might be prevented, and property saved, and danger and annoyance to relations avoided, if the disease could be more certainly diagnosed in its early stages? It seems probable that this constant rise in the evening temperature will be found to exist in all progressive brain diseases, and may be found as useful in the diagnosis of other obscure organic affections of the brain as

in general paralysis. To know in many cases whether the brain is affected with the beginning of organic disease is one of the most difficult problems the physician ever has to solve. This constant increase of evening temperature in general paralysis seems to confirm Bayle's original theory, that the disease is of an inflammatory nature.

One day's observation is not at all sufficient to determine that the increase of temperature does or does not exist in the evening in general paralysis. On some days I found the evening temperature lower, especially in the second stage of the disease. It is necessary to take the average of a number of observations.

The difference between the evening temperature of this disease and the morning temperature of complete dementia is 1.41°. The temperature is high in the first stage of general paralysis, lower in the second stage, and again very high in the third. (See Table II). The evening temperature is most increased as compared with the morning temperature in the third stage, and least in the second.

In the phthisical cases the evening temperature was higher than the morning, but not so much so as in general paralysis. It depended entirely on the stage of the disease, whether in any one case the evening temperature was higher. If the disease was active and the temperature increased much above the normal standard of health, then it was always higher in the evening. If the disease was not active it was not so increased. Out of the nine cases there were four in which it was increased and five in which it was not; but the increase was so great in those four that it brought up the average. On the whole the temperature in the phthisical tends to be high, whether the tuberculisation is active or not. It was never below 97° in any of them; never went above 98.5° where the disease was not active; but was seldom below 99°, when it was active, and sometimes rising to 101.3°. These observations refer to the *average* temperature, for I have found it to be only 96° at times in such cases, and I one evening found the temperature of a woman, who had acute tuberculosis, and who was never under 100° at any other time, to be only 98.6 . The difference between the evening temperature of phthisis and the morning temperature of complete dementia is 2.51°, which is the greatest difference in any of the averages.

If we compare the average morning temperature of all the

patients examined with the average morning temperature of the sane, we find that in the sane it is .19° higher, while the evening temperature of the insane is .49° higher than that of the sane. This proves that the increase of the evening insane temperature is an absolute increase over what is normal, and not a mere relative increase over a low morning temperature, as might be the case if it was due merely to a languid circulation and weak vital energy. In that case the temperature would be low through the day, while the patients were up, and would be more near the normal standard when they were warm in bed, but it would never go beyond the normal standard. In the morning, only epileptics, acutely excited patients, general paralytics, and the phthisical come up to the sane standard; in the evening they *all* go above it, mild dementia making the nearest approach to it, and complete dementia, which is .56° lower in the morning, rising .3° above it at night.

If a slight difference from the ordinary rule of health in regard to the rising of the evening temperature has such a fatal significance in general paralysis, I think we may conclude that the same tendency in a lesser degree points in the same direction in the other forms of insanity, confirmed as it is by our experience of the death rate in them. It is a sure index of the tendency to death—in other words, it expresses all the latent disease, and the inability of the vital forces to resist disease, which exist. Unfortunately, we find that in a certain proportion of the sane and healthy, the usual rule of health as to the fall of the evening temperature is reversed; so that we cannot take this as a sure diagnostic sign in individual cases. But on looking over a list of the names of all my patients, whose evening temperatures are higher than their morning temperatures, while many of them seem quite healthy, yet I find in it nearly all those whom I suspect of having brain disease, and most of those whom I imagine to be predisposed to phthisis. In the sane (see Table I), I found that 27 per cent. had this peculiarity, while in the insane there were 41 per cent. Doubtless this extra 14 per cent. all represents *progressive disease;* but inasmuch as in many of them the increase was very slight indeed, I think the average temperatures are a more sure criterion. Looked at in this light of the significance of small variations of the morning and evening temperature, we can see better the meaning of the slight

differences in the *mean* temperature of the various forms of insanity. A small part of a degree of difference in the animal heat when it is a constant concomitant of a certain form of insanity, as shown by the average of a large number of cases, seems to have as definite a meaning as the difference of three degrees in a case of acute febrile disorder. In the one case, it enables us to tell the strength of the tendency to death in the class; in the other case it enables us to predict life or death to the individual. The thermometer has first been applied for the latter purpose, and its indications studied; but I should not be surprised if it gave most interesting and important results, if applied in the former way also. Would it not tell, if applied in the case of a large number of people living in the neglect of proper hygienic conditions, that the laws of nature were being broken? Might it not give indications if unwholesome, or insufficient, or too abundant diet were eaten? And might it not in many cases give the very first warning that some insidious disease was coming on? I confess I should be very uncomfortable if I found my evening temperature getting higher than the morning temperature, and if this was accompanied by any rise over the normal standard.

Differences of Temperature between various individuals labouring under the same form of insanity.—Such differences prevail most in epileptics, general paralytics, and acutely excited patients, but they exist in all the forms of insanity. Between different epileptics, I have found an average difference of 3°, while taking the highest observation of epileptic temperature I ever observed, without any actual disease being present (101.2°), and comparing it with the lowest, (94.8°,) there is a difference of 6.4°. In general paralysis the greatest difference of average temperature I have observed was 7.24°, between a man in the second stage, quiet and stupid, whose temperature was 95.76°, and another moribund patient who was 103°. This patient died, and the congested, almost pneumonic, state of the posterior part of the lungs, may have caused increased heat; I have, however, found the temperature to be 102.6° twenty-four hours after an epileptiform attack, which is an increase of 6.84° over the low temperature referred to. The greatest difference between any two single observations in general paralysis was 8.7°. In only five instances have I met with a temperature below 95°; one of these was an epileptic, one a general paralytic in the second stage, one laboured under mania, and two were demented. I was often surprised by finding a few

of the most completely demented persons to have an average or high temperature. There is an idiot here who is 98. 4°. A weak circulation at the extremities is by no means always accompanied by a low temperature. One woman, whose hands used to get quite purple and swollen, and as cold as lead if she were away from the fire for half an hour, had a temperature of 98.5° in the axilla at the time. It is not uncommon to find the temperature in the insane between 95° and 96°; but I found among the attendants here two men and one woman, strong and perfectly healthy, whose temperatures were under 96°, two of them being so both in the morning and evening, and the third in the evening. I was most particular too, in taking those cases, and the mercury would not go above 96°, however long the thermometer was left under the arm. The greatest difference noticed between any two of the sane persons was 3.6°. I found two of them had an evening temperature 1.5° above their day temperature. The highest sane temperature was 99.2°.

Differences in the same person at different times and in different mental states.—I examined twelve patients in all the gradations of mental state, from depression up to acute excitement. The general result was that the temperature was decidedly higher in acute excitement than in depression or quiescence. Where short attacks of mania rapidly succeed each other periodically, the difference is not so marked as in the case of periodic mania coming on at long intervals. In four of the latter cases the difference between the average temperature taken in the slightly depressed state and in acute excitement, was 2.2°; while the average difference between excitement and depression in the twelve cases was 1.1°. The exact periods of the highest temperature varied greatly; in five of the twelve cases it coincided with the acme of the excitement, in two cases it preceded this, in two cases it followed it and existed in the subacute stage, in one it was quite variable, and in two this period of the most acute excitement was the time of the lowest temperature. The greatest difference I observed in the same person, excited and quiet, was 3.6° in mania, 4.7° in epilepsy, and 5.8° in general paralysis. In the latter disease I found that in two of the patients, in whom the fits had existed almost since birth, the very lowest temperatures existed at times, while at other times the very highest temperatures existed. The effect of epileptic fits on the temperature is a very interesting and complicated subject. I do not propose to go fully

into it here, not having determined all the points connected with it. The immediate effect of an epileptic fit is to depress the temperature, and if the patient is in bed and goes to sleep after the fit, it will sometimes go down for three hours at the rate of .75° per hour. A fit taken during the day depresses, and afterwards slightly raises the temperature. Two fits taken during the night almost always raise the temperature 1.5° in the morning. Two fits taken during the day depress slightly, and then nearly always raise the temperature 1.2° in from one hour to five from the time of taking the last fit. If one or two fits produce a stupified, confused state lasting for many hours, the temperature is sometimes raised 3° or even higher; but this is rare, and even when it is the case it always falls again within twelve hours. I have only observed it three times in over 500 observations on epileptics.

One of the most interesting facts observed by me was the effect of an epileptiform fit in general paralysis. I found that the temperature was always much raised after such an attack. After sinking slightly for an hour or two, it began to rise, and went up in twenty-four hours 2.5°, and in thirty-six hours 6.6°, in one case after two such attacks. Even one such fit—not very severe, and passing off at once, and the patient getting up in the morning as if nothing had happened—caused an increase of 3° in three days; and this is the peculiarity of those attacks, that the patient's temperature is left for some time higher than it had previously been. It is often exceedingly difficult to tell such fits from true epileptic fits in the beginning of disease. When, as I have known to happen, a man about whom nothing had previously been noticed wrong mentally, falls down in "a fit," from the description of which, by the relatives, no medical man could well distinguish it from epilepsy—in such a case, if the temperature was found to rise up to 99° or 100° steadily for two days; and if the temperature was higher at night than during the day, I should have but little hesitation in pronouncing the case to be one of general paralysis, though no other symptoms were present. In the ordinary forms of insanity, I have found masturbation to cause an increase of temperature almost equal to an epileptiform fit in general paralysis.

Temperature in the different periods of life in the insane.—When all the cases examined (except those under twenty, they being too few to give any trust-worthy result) are analysed and arranged into three periods of life, viz., from

TABLE III.

Ages.	No. of cases examined.			Morning Temperature.			Evening Temperature.			Mean Temperature.			Difference between Morning and Evening.			Per centage of cases in which Evening Temperature was higher than Morning Temperature.
	M.	F.	T.	M.	F.	T.	M.	F	T.	M.	F.	T.	M.	F.	T.	
				deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	
Between 20 and 40 ...	76	41	117	97·42	97·7	97·51	96·9	97·42	97·07	97·16	97·56	97·29	·52	·28	·44	32 per cent.
,, 40 and 60 ...	71	56	127	97·34	97 25	97·3	97·11	97·02	97·08	97·23	97 14	97·19	·23	·23	·22	42 ,,
Over 60	25	28	53	96·72	97·01	96·88	97·09	96·79	96·93	96·91	96·9	96·9	·37	·22	·05	57 ,,

twenty to forty, from forty to sixty, and over sixty years of age, and then the averages taken, as in Table III., no regard being paid to the forms of insanity, the following results are obtained:

The morning temperatures get lower each twenty years, being .63° lower in the patients over sixty than in those above forty.

The evening temperatures get lower also, but not to such an extent, being only .14° lower over sixty than above forty.

The difference between the morning and evening temperature therefore increases, being .49° more over sixty, than under forty. Over sixty, the evening temperature is higher than the morning temperature.

The per centage of cases in which the evening temperatures are higher than the morning temperatures, rise from 32 per cent. under forty, to 57 per cent. over sixty.

The morning temperature of those under forty, nearly corresponds with the sane morning temperature, the morning temperature of the older patients being below this, while all the evening temperatures are considerably above it.

The general lowering of the temperatures is, no doubt, owing to the diminished vital power as life advances, while the slow rate of decrease of the evening, as compared with the morning, is, no doubt, explained by the larger proportion of organic brain disease among the older patients keeping up the average evening temperature, thereby showing the greater tendency there is to death at the more advanced ages. As we saw from Table I., that when the average evening temperature gets considerably above the morning temperature, in any form of insanity, as in the phthisical and general paralytics, it indicates a very high death rate; so we find here that this law holds good, for over sixty the death rate is very high from organic affections of the brain, especially among males, and among the men over sixty the evening temperature is much above the morning. Anyone who has performed many *post mortem* examinations among the insane knows how often softenings from atheromatous arteries, &c., are found in patients above sixty.

TABLE IV.

Form of Insanity.	Morning Pulse.			Evening Pulse.			Mean Pulse.			Difference between morning & evening pulse.		
	M.	F.	T.	M.	F.	T.	M.	F.	T.	M.	F.	T.
Mania	81	89	84	71	82	76	76	85	81	10	7	8
Melancholia	78	82	80	71	74	72	74	78	76	7	8	8
Dementia (mild)	81	79	80	75	75	75	78	77	78	6	4	5
Dementia (complete)	73	86	80	71	77	74	72	81	77	2	9	6
General Paralysis	92	...	...	83	...	...	88	...	...	9	...	..
Phthisical	88	105	96	78	100	88	83	103	92	10	5	8
Convalescent	81	79	80	72	73	72	76	76	76	9	6	8
Averages	82	87	84	74	80	77	78	83	80	8	6	7
Healthy Persons	77	84	80	70	78	74	74	81	77	7	6	6

Temperature in relation to the pulse.—In Table IV., the average frequency of the pulse is given in the different forms of insanity. We see that while the mean frequency of the pulse corresponds almost exactly to the temperature, rising and falling with it in the different forms of insanity, being highest among the phthisical (92), the general paralytics coming next (88), the rate gradually falling in mania (81), mild dementia (78), complete dementia (77), and melancholia and the convalescent (76), the rate in healthy persons being 77. Mania, general paralysis, and phthisical mania are the only forms in which the mean pulse is markedly higher than in health, while the general frequency of the pulse among all classes of the insane is somewhat higher than in the healthy, just as the temperature was found to be. The *mean* rate of frequency corresponds very closely with the usual rule in regard to individuals suffering from disease, viz., that ten beats of the pulse correspond to a degree of temperature.

We do not find that in any form of insanity the average frequency of the pulse is greater in the evening than in the morning. In this respect it does not correspond to the temperature, and the rule mentioned above is actually reversed. Even among the phthisical, this tendency, which was present among those suffering from the acute forms of the disease, was quite counterbalanced by the opposite tendency among those who had the less rapid forms of consumption.

In dementia there is a tendency for the evening pulse to rise, the morning remaining at about the average, so that the difference between the morning and evening becomes lessened. On the whole, the difference between the evening and morning pulses among the insane is greater than among the sane.

I noticed a very curious fact in respect to temperature in inflammation: four of the patients, whose temperatures I had previously taken, happened to have inflammations—two of them of the leg below the knee, one of the groin, and one of the foot. During the course of the inflammations, the temperature in all of them was increased, and was higher in the evening than in the morning; the pulse, too, being higher in the evening, as is usual in inflammatory and febrile affections. But after the inflammation had disappeared, and the parts healed, when the morning temperature and pulse were down to their normal standard, and when the evening pulse had sunk below the morning pulse in frequency, yet *for many weeks the evening temperature remained higher than the morning temperature.* In all of them I had ascertained that this was contrary to their usual state in health. In three of them it gradually got lower, till it reached its normal state; while in the other it yet remains higher in the evening. This would seem to show that the rising of the evening temperature is a far more delicate test of latent disease and its effects, than the pulse or any other test known to us. Or is it that when the system gets into the feverish habit, as it were, it retains it for some time after the actual disease has disappeared? At all events, it is a phenomenon well worth attention and study in a larger number of cases.

The general results of my observations may be thus summed up:—

1. The temperature of the body is higher in the insane than in the sane.

2. The temperature is highest in phthisical mania, gradually falling in the following order:—General paralysis, acute mania, epilepsy, melancholia, mania, mild dementia, and complete dementia.

3. Dementia is the only form of insanity whose average temperature is below health.

4. The great characteristic of all the forms of insanity, is that the difference between the morning and evening temperature is much less than in health, and this is owing to

the rising of the evening temperature, and not to the lowering of the morning temperature as compared with the healthy standard.

5. This rising of the evening temperature as compared with the morning is in the exact ratio of the death rate among the various forms of insanity, finding its acme in general paralysis.

6. In general paralysis, the average evening temperature is higher in every case than the morning temperature (the observations being taken over a sufficient period).

7. In phthisical patients the temperature is high, and is especially high in the acute forms of the disease, but the latent forms cannot be certainly diagnosed by thermometric observation.

8. The evening temperature of *every* form of insanity (even complete dementia) is higher than the evening temperature of health.

9. The greatest differences in different individuals labouring under the same form of insanity are found in general paralysis, epilepsy, and acute mania. In the first named a difference of 8.7° has been found.

10. Excitement in a patient is almost always attended by an increased temperature as compared with depression or quiescence. This difference averages 2·2° in periodic mania with long periods, and 1·1° in periodic mania coming at shorter intervals. In general paralysis there may be a difference of 5·8° in the same individual in different stages of the disease.

11. An epileptic fit depresses the temperature at first, and then tends to raise it a little, but it makes a difference whether the patient sleeps or wakes after the fit.

12. The epileptiform fits of general paralysis are always followed by a greatly increased temperature, lasting for several days, and they may in this way be distinguished from ordinary epileptic fits.

13. The average temperature falls as the patients get older, but the fall takes place chiefly in the morning temperature.

14. The *average* frequency of the pulse in the various forms of insanity corresponds with the *mean* temperature, but the rise in the evening temperature has no corresponding rise in the evening pulse.

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EXPERIMENTS

TO DETERMINE THE PRECISE EFFECT OF

BROMIDE OF POTASSIUM IN EPILEPSY.

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What asylum physician is there, who, in prescribing drugs for his patients, has any approach to a feeling of certainty that these drugs will have the effect he anticipates? I refer more particularly to sedative drugs. Is there any such physician who will lay down a rule by which it may be known whether opium, hyoscyamus, Indian hemp, or bromide of potassium is the best medicine to be given in a particular case? We have the statements of individual authors in regard to the right mode of giving some of these drugs, but after all those are merely opinions founded on most limited observations, and lack the exactitude of research, and the numerical basis on which alone scientific truth is founded. It is no wonder that many of our specialty are sceptics in regard to medical treatment in insanity, when we generally find that the advocates of particular medicines, or of special modes of administering them, merely give us "selected" cases. To anyone who has read something of the history of medicine, it seems a mere waste of words to advocate any new treatment of a disease, except it is clearly shown that the spirit of fairness and scientific impartiality has regulated the observations on which the would-be conclusions are founded. And as for discussing and quarrelling over the general question of the good effects of medical treatment *versus* moral treatment, surely the energy and acuteness so expended would be employed to far more purpose in observing and recording facts, so that we might have something certain on which to base an argument on the one side or the other. And by observing facts, I do not mean vaguely noticing the course of certain random cases subjected to unsystematic and desultory treatment, and accepting the confused impression of the result left on the mind as scientific truth, on which an argument may be founded or a

boon to humanity conferred. It is surely possible for the physicians of asylums to combine their opportunities for observing the treatment of disease in one vast and systematic effort, all working on the same plans, and all adopting the same conditions. What accuracy might we not acquire in our notions as to the effects of morphia given in melancholia, if the drug was tried in the case of every melancholic patient in all our asylums for a year, and an accurate record of the results drawn up? The idea may seem in many respects chimerical and absurd, but it seems questionable if much accuracy in therapeutics will ever be attained until something of the kind is done. There is no single man who has opportunity sufficient to solve such a problem, except by careful experiments extending over years, and we know how difficult it is for a physician to continue careful experiments over long periods. And surely this exact, scientific, and statistical age will not allow the present state of utter doubt to continue much longer without making at least an effort to dispel it. We require to know the full and true result of giving drugs in every case, and not merely in a few favourable cases which may be natural recoveries.

Possessed with these ideas, and feeling conscience-smitten oftentimes at the uncertain way in which I gave drugs, and thinking that the action of the bromide of potassium in epilepsy, and that of opium in mania, afforded as simple fields of observation as could be found, I performed some experiments with those medicines. In regard to the bromide of potassium, my objects were to ascertain its precise effect: 1st—On the number of the fits. 2nd—On the character of the fits. 3rd—On the patient's mental condition between the fits. 4th—On the patient's weight, temperature, pulse, and general health. 5th—On the different varieties of the disease. 6th—To ascertain the most effectual dose for therapeutic objects. 7th—To determine the limits to which it may be pushed as to time and quantity. 8th—To find out the length of time to which its effects extend when it is stopped. To effect these objects I had all my male epileptic patients—29 in number—weighed, and took their morning and evening temperature and pulse every week for a month, having the number of fits recorded and the general mental state. This was when on their ordinary diet, and taking no medicine. I then gave them all bromide of potassium three times a day, one dose after each meal. I began with five grain doses, being fifteen grains per day. I gave that quantity for three weeks, increasing the dose at the end of that time to ten grains, continuing this for three weeks, and increasing the dose by five grains at the end of

every period of three weeks until forty grain doses were reached. In case any ill effect might result from this or larger doses, I continued to give forty grains for seven weeks, so that I might have time to observe the patients carefully. At the end of that time I gave them forty-five grain doses for three weeks, and then fifty grain doses for ten weeks longer. I then stopped the medicine in all the cases. During all this time (thirty-eight weeks) the number and kind of fits had been noted, the patients had been weighed, and their temperatures and pulses examined and noted every week, while they had been otherwise subjected to very careful observation as to their mental and bodily state.

Effect of the medicine on the number of the fits.—I have put in a tabular form (see table I.), the results of my observations in regard to the number of fits taken by the patients when they were not taking the medicine, and during each of the periods of three weeks when they were taking the different doses of the drug.

TABLE I.

Quantity taken per day.	No. under treatment.	Total No. of fits in three weeks.	No. of fits to each patient in three weeks.
No Medicine	29	398	13·5
15 grains	29	344	11·9
30 ,,	29	269	9·3
45 ,,	29	348	12
75 ,,	29	174	6
90 ,,	26*	61	2·3
105 ,,	26	64	2·5
120 ,,	25	86	3·4
135 ,,	25	58	2·3
150 ,,	20†	48	2·4

As various causes prevented me from continuing the experiments in the cases of all the patients on whom they were begun, I have given in one column the number of

* One patient had taken acute rheumatism, one had turned over in a fit and died, and in the third, a boy of 15, the medicine had to be stopped.

† Besides the above it had to be stopped in four more cases, on account of its ill effects; in another boy I did not go on to the large doses; and in the ninth patient the delusion that it was poison I was giving him was so strong that I did not continue its use all the time.

patients under treatment. By some mistake, the patients, after having been three weeks on fifteen grains three times a day, were put up to twenty-five grains, instead of the usual increase of five grains, so that in the column containing the quantity of medicine given to the patients it will be found that there is a leap from forty-five to seventy-five grains.

From this table it is seen that the total number of fits taken by the patients in three weeks diminished from 398, when the patients were taking no medicine, to forty-eight when they were taking 150 grains a day. But as there were only twenty patients under observation at the latter period, and twenty-nine at the former, we have to look to the last column to ascertain the ratio of fits to each patient. From this we see that the average number of fits taken by each patient was 13·5 with no medicine, that it fell to 11·9 under fifteen grains a day, to 9·3 under thirty grains; there was a leap up to 12 under forty-five grains, but that this increase was accidental seems to be shown by the number falling to 6 under seventy-five grains, and to 2·3 under ninety grains. This was the lowest point reached. After this, while the patients were taking from 105 up to 150 grains daily, the number of fits remained wonderfully uniform, not varying much from 2·4 to each patient. I kept them for ten weeks on 150 grains daily, and the average number of fits remained very uniform during all that time. The number of patients under treatment was evidently sufficient to give a very uniform and fair average, and to correct the imperfect results of treating individual cases.

The relative number of fits taken by the patients from six o'clock a.m. till eight o'clock p.m., as compared with those taken from eight p.m. till six a.m., was completely altered by the medicine. During the thirteen weeks which elapsed from the time the patients were placed under observation until they began to take twenty-five grain doses of the medicine, the number of fits taken during the day greatly exceeded those taken during the night, while after that time the fits taken during the night always exceeded those taken during the day. When taking no medicine the night fits were only eighty per cent. of the day fits; after they had taken fifty grain doses of the medicine for ten weeks, the night fits were twice as numerous as the day fits. The average number of fits to each patient was diminished to about one-sixth, the day fits being lessened to one-twelfth, and the night fits to one-third of those taken with no medicine.

The above being the results, taking all the patients together, we shall next examine the results in regard to each of the

patients separately. In table II. I have given the average weekly number of fits before and after taking the medicine in each case.

TABLE II.

Names.	Average No of fits per week without medicine.	Average No. of fits per week with medicine.	Percentage of reduction.	Names.	Average No. of fits per week without medicine.	Average No. of fits per week with medicine.	Per centage of reduction.
J. G.	36	4·4	718	H. O.	2·3	1·7	35
P. Mc.	5	·8	525	J. F.	2	1·6	25
T. S.	1·5	·3	400	T. J.	3·7	3·2	16
W. G.	4·1	1	310	T. F.	5·5	5·3	4
W. M.	7·2	1·8	300	T. K.	6·2	10·3	...
J. B.	5	1·3	290	F. L.	2	2·4	...
J. B.	7·7	2·4	220	R. S.	1	2·5	...
J. D.	1·7	·6	183	*			
R. M.	3·7	1·6	131	T.W.H.	·84	·1	740
W. L.	2	·9	122	J. Y.	1·81	1	171
J. W.	9·5	4·5	111	R. Mc.	1·23	·7	76
J. B.	14	7	100	J. C.	·3	·2	50
T. W.	1·7	1	70	J. G.	·3	·2	50
J. P.	8	5·2	54	J. S.	·3	·4	...
J. P.	1	·7	43	T. J.	·3	·4	...

This table is so far defective that the average without medicine was only taken, in most of the cases, over four weeks, while with medicine it is over thirty-four weeks. Then, too, the full effect of the larger doses of the medicine is not shown in the table, because in most of the cases the larger doses were vastly more effectual than the smaller doses. But taking the table as it stands, we see that in one-half the cases the number of fits were reduced to or below one-half of their previous number, while in one-fourth of the cases they were reduced to below one-third of their previous number, and in two cases to about one-ninth of the average number taken without medicine. Even this does not at all represent

* Below this are patients who took fits at very irregular intervals, in whom therefore I took the average number of fits without medicine over a period of 13 weeks instead of 4.

the true result of large doses. In the case of J. G., at the head of the list, who took thirty-six fits per week without medic ne, after he had got up to half drachm doses he had no fits for ten weeks, and only had four fits for sixteen weeks thereafter. The reduction in this man's number of fits, therefore, amounted to 24,000 per cent! In another case, W. M., the average without medicine was 7·2 fits per week, while after he had got up to half drachm doses of the medicine he only had twenty-two fits in twenty-six weeks, amounting to a reduction of 806 per cent. Another case, W. G., had 4·1 fits per week without medicine; after he had got up to half drachm doses, he had only eleven fits in twenty-six weeks. This was a diminution of 876 per cent. Another case, P. Mc., had taken five fits per week, and after half drachm doses, was reduced to seventeen fits in twenty-six weeks, or 670 per cent. T. S., the third in the table, had, on an average, 1·5 fits per week; after he got half drachm doses he only had one in twenty-six weeks, showing a reduction of 3,650 per cent. J. D. had taken 1·7 fits per week, and only took six in twenty-six weeks, being a diminution of 640 per cent. J. F. took on an average two fits per week, while after getting up to half drachm doses of the medicine, he only took thirteen in twenty-six weeks, showing a diminution of 300 per cent. Had those seven patients not been taking any medicine they would have taken 1,495 fits in twenty-six weeks; as it was, they only took 74 fits in that time.

In only five of the twenty-nine cases were the number of fits more numerous after the medicine was taken than before; and in the only one of those (T. K.) in which this was markedly the case, the fits, which had been most severe before, were quite altered in character, and became much less violent after he took the medicine. He used to throw himself out of bed, and often to bruise himself severely during every fit he took at night before he got the medicine; he never did so afterwards. Another man (J. S.) in whom the fits were slightly more numerous, after getting the medicine became greatly more amiable and improved in mind.

Effect of the medicine on the character of the fits.—In seven cases out of the twenty-nine there was a most marked change in the severity and length of the convulsive state, and of the succeeding coma. In two cases, where the patients threw themselves about during some of the fits, and took others in the ordinary way, they have never had one of the former kind since they began to take—the one fifteen grain, and the other thirty grain doses. One lad, who rushed forward with extreme violence during the tonic stage of convulsion, and threw himself out of bed at night, has, to some extent, lost

this tendency. In another, the fits, when they do come on, now resemble more the *petit mal*. Besides those nine marked cases, the fits seem, on the whole, less severe in fully half the others. In no case has there been noticed any aggravation of the severity of the fits. In one of the cases I have referred to as throwing himself about during certain of the fits he took, he saw a bright light fully half a minute before the fit. This light became brighter, and seemed to come nearer until it reached his eye, when unconsciousness came on. He tells me he has seen this light on several occasions since he took the medicine, but it never "came near."

Effect of the medicine on the patients' mental state between the fits.—In seven of the patients, the characteristic irritability and tendency to violence of epilepsy were most wonderfully lessened. Not only were the attacks of very marked and extreme irritability after or before fits almost abolished, but their normal mental condition became by far more rational. Those were some of the worst cases in the house. In three cases who had never before been able to go to chapel, to the amusements, or out to work, on account of the fits, they now go regularly to all of these; and consequently, life to them has far more of enjoyment and happiness than it had before.

The condition of these patients as regards comfort and safety to themselves and others, is most markedly improved, yet when the patients were imbecile before, they remained imbecile under the use of the medicine. It must be kept in mind that all the cases were of old standing, and many of them reduced to almost total dementia by the fits. Diminution of nervous and mental irritability was the one characteristic feature in those who benefited by the use of the drug. As the larger doses were approached, some of the patients became very torpid and somnolent. In three cases this was most marked. In two of them the medicine had to be stopped for this reason alone, when they had got up to forty-five grain doses thrice a day. In twelve of the other cases, where the alteration in the mental condition was not quite so great as in those seven, there has been on the whole a marked improvement. In ten of them there has been no perceptible change in their mental state. I have referred to one case where there has been a marked improvement in mental state, who has, nevertheless, slightly more fits per week with the medicine than without it.

Of the twenty cases who have taken the medicine all the time, only six of them have been excited or maniacal to any extent, and those on one occasion each, since they had twenty-five grain doses of the medicine. Only two of those had attacks of true epileptic mania.

Effects on the Patients' Weight, Temperature, Pulse, and General Health.—There is scarcely any surer rough test of health among a number of persons subjected to the same conditions as regards diet and exercise, than ascertaining their weight at stated intervals. As a means of testing the effects of any medicine on the general health, given as I gave the bromide of potassium, I regard it as even more valuable. It is impossible that any drug could act as a slow poison without bringing down the weight.

The general weight of the patients remained wonderfully uniform while taking the 5 and 10 grain doses. Taking the united weight of the 27 patients at the end of the 10 grain period,* there was only a loss of two pounds. (See Table 3.)

TABLE III.

Amount of Bromide taken per day.	No. of patients.	Original aggregate weight with no medicine.	Aggregate weights while taking the medicine.	Number who gained in weight.	Number who lost in weight.
30 grains	27	4,136 lbs.	4,134 lbs.	12	15
90 ,,	24	3,663 ,,	3,708 ,,	17	7
120 ,,	20	3,076 ,,	3,132 ,,	14	6
150 ,,	19	2,904 ,,	2,922 ,,	11	8

At that time 15 of them had lost weight, while 12 had gained, but the greatest difference in any one case was only seven pounds. By the time the patients had got up to half drachm doses there was an increase of 45 pounds in the united weight of the 24 who were then taking the medicine. When they had been three weeks on 40 grain doses their united weights amounted to 56 pounds more than before they were put on treatment. This was an average increase of two pounds and three quarters for each of the 20 who were then taking the medicine, and only six of them had lost weight, while 14 had gained. One man had gained 15 pounds, but, with that exception, the gains had been pretty uniform and equally distributed. The greatest loss had only been five pounds. After the patients had been taking 50 grain doses for ten weeks, the aggregate weight of the 19 then under treatment was still 18 pounds more than it had been at first; but then this showed a loss of 40 pounds since the same patients had been on 40 grain doses of the medicine seventeen

* Two of the patients were boys whose weight was regularly increasing as they grew, so that I did not include them.

weeks before. They had all lost weight in that time except eight, and six of them had lost over six pounds each, while one had lost twenty pounds. The tendency was certainly to lose weight at that time, but this may have been partially accounted for by the fact that the time of year was summer, when most people lose weight. Taking those nineteen patients, eleven of them had gained in weight at the end of the nine months during which they had been under treatment.

There had been a continuous upward tendency, till the doses were forty grains three times a day in the month of March, and then the aggregate weight began to fall.

While the above was the general result, taking all the patients together, yet in four of the five cases in which the medicine had to be stopped on account of its causing ill effects, those patients had been losing in weight for a week or two when the other ill effects were coming on. Practically, the regular weighing of the patients under treatment was a very important matter, indicating, amongst other symptoms, when the drug should be stopped, or the dose lessened. In one of the cases the dose was reduced by one half, and the patient at once began to pick up in weight. The patients lost from three to twelve pounds in a week when the medicine was causing other ill effects.

Temperature.—In a former paper in this journal * I stated that I had found the average temperature of epileptics to be 97·48° in the morning, and 97·38° in the evening. Those results were obtained from the same twenty-nine patients I subsequently put under treatment for epilepsy. The average temperature after the patients had got up to ten grain doses was 97·35°; after they had got up to thirty grain doses it was 97·39° in the morning, and 97·27° in the evening. At the forty grain doses it was 97·17° in the morning, and 97·26° in the evening. This showed a slight falling in the temperature. According to the results of my previous investigations a morbid or fatal tendency in any class of cases is soonest and most certainly shown by a rise in the evening temperature over the morning temperature, or an approach to this. No such result seemed to be caused by the medicine up to that point. The average temperature of the twenty cases who continued to take fifty grain doses for ten weeks, was, at the end of that time, 98·16° in the morning, and 97·91° in the evening. This is ·68° higher than the normal morning temperature of epileptics, and ·53° higher than their evening temperature; but the weather was very hot at the time the patients were taking the fifty grain doses, and this may account for the increase at that time.

* April, 1868.

In the cases where this medicine had to be stopped on account of its ill effects an increased temperature was always observed. In one case it rose to 99·8°, in two others to 100°, and in one to 101·2°. In those cases, too, the evening temperature was always raised above the morning temperature. The lowering of the temperature observed by me at first agreed with recent German investigations into the physiological effects of the drug. When patients are taking many fits, too, in quick succession, their temperature is apt to become higher, and the average temperature might have been lowered on account of the fewer number of the fits taken.

Pulse.—The average normal pulse of the patients was 83 in the morning and 76 in the evening. During the ten grain dose period it was 82 in the morning and 72 in the evening; during the thirty grain dose period it was 83 in the morning, and 73 in the evening; during the forty-grain dose, it was 77 in the morning, and 70 in the evening, and at the end of the fifty grain dose it was 80 in the morning, and 73 in the evening. There was a tendency to fall, therefore, up to forty grain doses.

General Health.—During the time the patients took the medicine, with certain exceptions, they ate well, slept well, and all their bodily functions were unimpaired. It never produced sickness in a single case, except one, and this was obviated at once by being more diluted, and I never could make out that it affected the stomach and bowels in any way whatever. I had not the means of ascertaining its effect on the sexual function. It did not seem to impair the energy of the nervous system in the majority of the cases to any abnormal extent. As we have seen, it certainly in many cases reduced the superabundant and morbid energy and irritability. In some of the cases it certainly increased the appetite.

To those general statements there were certain exceptions. Out of the twenty-nine cases the medicine had to be discontinued in five on account of the ill effects it produced. The first case in which these ill effects were seen was in a boy of fifteen, who had taken fits almost from birth, who took an average of 5·5 per week without medicine, and who at the end of eleven weeks from the time the medicine was begun, and when he had been getting twenty-five grain doses for a fortnight, became drowsy and feverish, fell off his food, his tongue became coated with a thick white fur on each side, with a raw line down the middle, he lost weight, and had slight pneumonia at the extreme base of both lungs. In his case the fits had increased in number after the medicine had been pushed beyond ten grain doses, and they increased still

more after the medicine was discontinued. In about a week after the medicine was discontinued he was in his usual state of health, with the exception of the increased number of fits, and it was three months before they came down to the average. After that, however, they became very infrequent. The next cases in which ill effects were manifested were two men, the one thirty and the other forty years of age, both of whom had taken fits from childhood, were quite demented, and took about two fits a week on an average. After they had taken the medicine for seventeen weeks, and had got to the end of the 35 grain dose period they both about the same time became drowsy and lethargic to an extreme degree, feverish, their tongues furred, and on examination double pneumonia for about the lower fourth of the lungs was found to exist in both of them. Previously to the coming on of this state the fits had ceased in both cases for about a month. They both recovered, but remained long in a torpid state of mind and body. As they recovered the fits began to come on as usual.

In the other two cases, one twenty-four and the other forty, both of them epileptics for many years, immediately after the two last had exhibited ill effects, and at thirty-five grain doses, the same symptoms began to appear, with the exception of the pneumonia. The medicine was discontinued earlier, being altogether stopped in one of the cases, and reduced to half doses in the other, and they both recovered their usual mental and bodily condition in a fortnight thereafter.

The torpid state I have described seemed to me to result from a partial suspension and paralysis of the activity of the whole cerebro-spinal system. I could not detect any special effect on the functions of the spinal cord more than on those of the cerebrum. On the whole the drowsiness and mental torpor preceded the bodily inactivity. The tendency to pneumonia seemed distinctly to point to an interference with the functions of the ganglia, from which the roots of the pneumogastric nerve spring. The motor inactivity, indeed, seemed to me to result rather from the want of stimulus from above than from direct paralysis of the cord. I did not notice any marked deadening of the reflex action of the cord. This is not in accordance with recent German investigations into the physiological action of the drug. I observed no affection of the ganglionic system of nerves. In two cases there had been, to begin with, unequivocal signs of partial paralysis of the legs, and the co-ordinating power of the muscles of the legs was much impaired. In one of these the medicine did not aggravate this affection. In the other it did so considerably after the fifty grain doses had been reached, but not till then.

Effects of the medicine on the different varieties of the disease.—Examining the seven cases in which we have seen the medicine to have had most effect in diminishing the numbers of the fits, do we find that they had anything in common as to age, length of existence of the disease, cause of the disease, kind and frequency of the fits, or in any other respect? I shall investigate the same points in regard to the patients in whom the medicine caused ill effects.

Those patients in whose cases the fits were most diminished were of all ages, from twenty-four to fifty-five. In all of them the epilepsy had existed for many years. In three of them, indeed, it had existed from childhood, and in one from puberty. In no respect does there seem to be anything in common. In all of them, indeed, there is a certain amount of intelligence left, but it varies much. In J. G's. case, the patient who was most benefited of any, he is very nervous at all times, being easily startled by impressions on his sensory organs, and the majority of his fits consisted of those in which the body was violently jerked and thrown about with no clonic spasm, and of those he has in the meantime quite got rid. He saw a bright light immediately before those fits came on. They are not invariably the patients who have gained most in weight, or whose bodily health has in any way improved most while taking the medicine. The numbers of fits taken by those patients vary considerably, from an average of 36 per week down to an average of one fit. On the whole, however, the good effects of the drug in diminishing the number of fits, and in improving the mental state, were more marked among patients who took frequent fits, than among those who took fits at very rare intervals. All those who took frequent fits were not materially benefited, but in only three cases out of nine, whose average number of fits was one a week or under, were the beneficial effects of the drug very strongly marked. In one such case, while the fits did not come on for fourteen weeks, yet the mental condition of the patient during that time was weaker and less rational than usual. This is the only case in which this result was seen, and it may have been a mere coincidence. Even in that case the irritability was lessened along with the intelligence.

In regard to the causes of the epilepsy in those benefited by the drug, so far as they were assigned or could be ascertained, they were various. In the seven cases most benefited four were from childhood or puberty, it was brought on by drinking in one case, it was the result of a blow on the head in another case, and in another the cause was unknown. In one case where there are marked signs of organic disease of the motor

centres, its good results in diminishing the number of the fits were very marked.

All the five cases in whom the medicine produced ill effects had the following characters in common. 1st—They had all taken the fits from childhood. 2nd—They were all demented in mind. 3rd—The fits, in all of them, were frequent, being more than one fit per week. As to age and cause of the disease, they differ much. In only one of the cases is there evidence of organic disease of the nervous centres.

The most effectual Doses of the Drug for Therapeutic purposes.—We have seen that while the patients were taking thirty grain doses thrice a day, the number of fits reached their minimum (Table I.); and that during this period also the maximum number attained an increase in weight (Table II.) At that dose the drug had not produced any ill effects on a single patient, except one boy of fifteen, to whom it was equivalent to twice that dose in an adult. At the thirty-five grain doses the drug had to be discontinued in three cases on account of its ill effects. There had been nothing in the patients' temperature or pulse at all to contra-indicate the continuance of the drug in thirty grain doses, while the diminution of their mental and nervous irritability was as great as when they took larger doses.

The most effectual doses of the medicine, therefore, so far as these experiments lead to any result, would seem to be half-drachm doses given three times a day, and considering the total absence of any sickness or other disagreeable effect in the case of any of the patients to whom I gave it in the way I did, there would seem to be some grounds for beginning with smaller doses and giving it after meals.

The limits to which it may be pushed as to time and quantity.—Since I began my experiments the latter part of the enquiry has been worked out by physiological enquirers, and as no increased therapeutic effect was resulting from the increased doses, while there was a tendency among my patients to lose the weight they had gained, and to rise in temperature, I did not consider it justifiable to continue the fifty grain doses longer than ten weeks. Altogether my patients took the medicine for thirty-eight weeks. It having been ascertained by Laborde that 240 grains is a poisonous dose, I saw no use in continuing 150 grains per diem for more than ten weeks. It might well have been that the hot weather was causing the rise in temperature and the loss in weight among my patients, but I could not be sure of this. My investigation was a therapeutical, rather than a physiological one.

To what extent are the effects of the drug permanent?—After

my patients had ceased to take the medicine, the number of fits taken in three weeks by the 20 patients who had been taking the medicine was 150, being 18 in the first week after giving it up, 76 in the second week, and 56 in the third week. In the fourth week the number fell to 39 ; but even this was four times more numerous than when taking the medicine. In the fifth week they took 46 fits, and two of them had maniacal attacks. Thus, instead of 2·3 fits per patient for three weeks, the number at once rose to 7·5, when the medicine was discontinued. In 5 cases the fits in these three weeks were more frequent than they had been at first; in 13 cases they were fewer, and in two they were equal in number. The man who took most frequent fits, and was most nearly cured, took only one fit in the first three weeks; but in the fifth week he began to "see the light," very frequently and very near. After this I began the medicine in all the cases.

General observations in regard to the effects of the medicine.— The preceding observations may be considered to some extent satisfactory, and to some extent unsatisfactory. My first object was to attain scientific accuracy in the method of making the experiments. Without this no accurate results could possibly have been attained. Certain of the results, viz., those relating to then umber of the fits, to the patients' weight, temperature, and pulse, and to the doses of the medicine, may be regarded as accurate so far as the number of cases under treatment can give any result. If the experiments were repeated in a sufficient number of cases, general laws might be laid down in regard to those points. The results in regard to the mental state, the general health, the character of the fits, and the varieties of the disease where absolute accuracy of observation is unattainable, may point towards the truth; but the number of observations on these points would require to be increased a thousand fold to establish general laws. Still, the knowledge arrived at by such a series of experiments, limited as their number was, is as light itself compared to the darkness of mind resulting from treating selected, scattered cases in the usual unsystematic, unscientific manner. I think that if we treated all our patients in asylums (where we have ample opportunities of doing so) in the same way for five years, we should then perhaps be able to argue the question of the value of medical treatment in insanity. I cannot but think that my observations furnish, at all events, an *a priori* assumption that medical treatment may in certain of our cases do much good.

I have tried the bromide of potassium in all sorts of cases in the same way as in epilepsy, but as yet I have not had a

sufficient number of any kind of disease under treatment to give reliable results. In a certain kind of mild insanity that accompanies the change of life in women, I have found it apparently a specific. But then the number of cases of the kind in which I have been able to try it have been very few. I shall have to reserve my observations on this, as well as on the effects of opium in mania, for another communication at some future time.

Summary.—1. Twenty-nine cases of epilepsy of old standing, all having the same diet, and subject to the same conditions, were subjected to systematic treatment by bromide of potassium after their normal condition as to fits, weight, temperature, general health, and mental state, had been ascertained and noted. I gave them gradually increasing doses of the medicine up to fifty grains, three times a day, and the treatment was continued for thirty-eight weeks, every particular in regard to the disease and in regard to their bodily and mental condition being noted every week during that time.

2. The total number of fits taken by the patients fell gradually under the use of the medicine to one-sixth of their average number without medicine.

3. The fits taken during the day were lessened to about one-twelfth, and those taken during the night to about one-third of the normal number.

4. The reduction in the fits was not uniform in all the cases. In one case it amounted to 24,000 per cent., in one-half of them to more than 100 per cent., and in five cases there was no reduction at all.

5. In one-fourth of the cases the fits were much less severe, in some being less severe, while as frequent as before.

6. In one-fourth of the cases the patients' mental state was very greatly improved. Nervous and mental irritability and tendency to sudden violence were wonderfully diminished in those cases, and they were the worst of the patients in that respect. Attacks of epileptic mania were diminished. In some cases the mental state was improved, while the fits remained as frequent as ever.

7. The majority of the patients gained considerably in weight while the doses were under thirty-five grains three times a day. Their aggregate weight was greater at the end of the thirty-eight weeks than it had been to begin with, though it began to fall after thirty-five grain doses had been reached.

8. The patients' temperature fell somewhat until they got up to fifty grain doses thrice a day.

9. The pulse gradually fell about seven beats up to forty

grain doses. After that it rose, but not up to its usual standard without medicine.

10. None of the patients suffered in their general health except five. All the others were benefited in some way, except one,

11. The ill effects produced by the medicine in those five cases were torpor of mind and body, drowsiness, increase of temperature, loss of weight, loss of appetite, and in three of them slight double pneumonia.

12. The cases most benefited by the drug were very various as to the causes, number, and character of the fits, age, and in every other respect. On the whole the cases who took most fits benefited most.

13. The cases in whom the medicine had ill effects had all taken fits from childhood, were all very demented in mind, and took more than one fit per week, but seemed to have nothing else in common.

14. The diminution of the fits and all the other good effects of the medicine reached their maximum in adults at thirty grain doses three times a day, while ill effects were manifested when thirty-five grain doses three times a day were reached.

15. There seemed to be no seriously ill effects produced in twenty of the cases by fifty grain doses of the medicine thrice a day, continued for ten weeks.

16. When the medicine was entirely discontinued in all the cases the average number of fits increased in 5 of the cases benefited, to or beyond their original number in four weeks; in 13 cases they remained considerably less. The total average during that time was a little more than one half the number of fits taken before the medicine was given, and the greatest number of fits occurred in the second week after the medicine was discontinued.

TWO CASES OF

RHEUMATIC INSANITY.

READ AT A MEETING OF MEMBERS OF THE

MEDICO-PSYCHOLOGICAL ASSOCIATION,

HELD AT THE

HALL OF THE FACULTY OF PHYSICIANS AND SURGEONS, GLASGOW,

APRIL 27th, 1870.

BY

T. S. CLOUSTON, M.D. EDIN.

GEO. P. BACON, LEWES.

TWO CASES OF RHEUMATIC INSANITY.

C. M., admitted January 17th, 1870, æt. 24. Married; wife of sailor; can read and write; Church of England; from Whitehaven.

History.—First attack of insanity. Mother died of consumption. Father alive and well, and no relative insane or rheumatic. In health she was of reserved and quiet, but of nervous disposition, steady respectable habits, and fond of her children. The predisposing cause of her illness seemed to have been an accumulation of debilitating and depressing influences; viz., ill-usage by her husband, poverty, cold, hard work, with insufficient food during the three years since she was married, and having nursed her second child for fifteen months up to the period of her attack. These things caused a certain amount of depression of spirits. The exciting cause of her malady was an attack of rheumatism, not of a very acute character, which had lasted for two months before she became insane. She had pains in the back of her neck, pains and much swelling of fingers, hands, feet, and legs, and some feverishness; but she was never so bad as to be quite confined to bed. A week before admission she quite suddenly ceased to complain of her rheumatic pains, and simultaneously with this relief she showed signs of mental derangement, and violent chorea of head, arms, and legs commenced. Her first mental symptoms were a sort of absence of mind and inattention to what was passing around her, taking no notice of questions put to her or of her children. Before being sent to the asylum, in addition to this mental inattention, there was great excitement. She tore her clothes, and tried to jump out of a second-story window into the street. She was quite sleepless, and the choreic movements had increased greatly in intensity. Her limbs were never still a moment, and she threw her whole body about. She had to be sent forty-five miles by rail to the asylum.

State on admission—Mental.—She is much excited, her memory almost gone, and with difficulty can be got to speak at all in answer to questions, but talks incoherently in monosyllables about the doctor who had attended her. The only question she can be got to answer is to tell her name. The existence of delusions cannot be ascertained.

Bodily.—She is a dark-complexioned woman with black hair; rather thin, muscles flabby. Eyes dark brown and sparkling feverishly, pupils contracted, equal in size. There are most violent choreic movements of the muscles of her face, head, arms, and legs. Anything she attempts to say or do voluntarily is accompanied by the most violent grimaces, twitchings, and contortions; reflex action diminished. Cannot articulate more than single words at a time, and those imperfectly. Can not walk, and was carried with extreme difficulty; no tenderness of spine, lungs normal, respiration twenty per minute, heart beating quickly but regularly, no cardiac murmur. Pulse 108, strong. Tongue clean and moist; won't take food. Urine clear, acid, sp. gr. 1015, no albumen or deposits. Had not menstruated since beginning of last pregnancy. Temperature 100·4°. Several bruises on body, especially over right buttock.

Progress of Case.—She was carried to bed and ordered beef-tea and some brandy. She did not sleep, and on the following day the choreic movements ceased in legs, which became now quite paralysed, and nearly devoid of common sensibility; the reflex action in them was gone. Bladder paralysed, and urine had to be drawn off once, after which she could always pass it. Muscles of eyelids and eyes quite under control. Not so the tongue, which she can scarcely put out at all, and then with a jerk to one side. Mental excitement abated, and speaks better. M. T. 99.4°, E. T. 99.6°, M. P. 80, E. P. 84. Takes liquid food; 8oz. wine, strong beef tea, and extra diet.

She improved slowly until on the 23rd January (six days after admission) her state was as follows: "Chorea much less severe, complains of pain in knees, evidently of a nervous kind, for pressure slowly and carefully made does not increase it. Common sensibility somewhat exaggerated in legs, and some power of voluntary movement has returned to them, but almost no power of reflex movement. Takes food well, bowels regular, no sweating, mentally confused, depressed, no memory, suspicious, won't believe a word said to her, wonders where she is and how she came here. M. T. 98.4°, E. T. 99°, M. P. 108, E. P. 100."

24th Jan.—To-day twitching of fingers only, except when she does any voluntary movements. More power of voluntary movement in left leg than right, which is almost paralysed. Right knee slightly swollen. Reflex movement slight, and more in left than right leg. Tongue twitches when put out, and goes towards right side. Temp. the same. She has hallucinations of sight and touch, saying that an old woman comes behind her and eats her food, so that she cannot get any of it, and that one foot has been cut off. Is depressed, weeps and groans.

29th Jan.—Has had a relapse; chorea worse in left arm; complains of pains in arms and legs. Complains of a burning feeling all over her. A large slough forming in right buttock, where it had been bruised. She complains much of the pain of this. She still can't tell quite the place touched on her legs, but when pinched she screams. Requires to be fed with a spoon, shows an aversion to food, though she is evidently hungry. M. T. 100°, E. T. 99°, M. P. 116, E. P. 116. She has no affection of sight, no sparks or motes before eyes.

5th Feb.—She now has so far recovered the power of her legs that she can stand. Chorea almost gone when she is making no voluntary movements. Mentally a mixture of stupor and depression, as before, and the hallucinations of sight and touch remain. M. T. 99.8°, E. T. 101°, M. P. 120, E. P. 120°.

She gradually improved, and her temperature fell until, on the 19th February, she was reported as having only very slight chorea in hands, but as still complaining of the pains in legs. Mentally she was still confused, but her memory was returning. M. T. 98.2°, E. T. 98°, M. P. 94, E. P. 100.

She did not progress quite steadily, for on the 23rd Feb. her M. T. was 99.2°, E. T. 99°, M. P. 100, E. P. 108, and was some days worse with the chorea than others; but yet she was so far improved as to be, on the 15th March, out of bed nearly all day, able to walk, but the reflex action was much impaired in legs, and the left hand partially paralysed, and she had the sensation as if she did not feel the ground under her feet. Tongue now is simply unsteady when put out. Mentally less depressed, but confused; very sceptical and very much inclined to hide herself from observation; fancies she is watched. Temp. down to 97.8° in the morning. Is 120lbs. in weight.

2nd April.—"Believes now what she is told, and is almost rational; but her right hand is swollen, though quite painless.

Chorea rather worse, and she can't sleep so well as usual." The sleeplessness increased, and the choreic movements began to trouble her exceedingly at night, and on the 4th her M. T. was 99.2° and her pulse 104 and weak. As an experiment I gave her twenty grains of chloral in the morning, which made her slightly drowsy, and quite stopped the choreic movements till the evening, when they came on again, and she could not sleep. I then gave her forty grains of chloral. She slept soundly; the chorea ceased; her temperature next morning was 97.3°, and her pulse 84 and stronger. Her mind had not been affected during this little aggravation of the chorea. The swelling of the hand remained for a day or two longer, and then gradually disappeared. Still the reflex action in foot was diminished, and she complained of intense heat of hands. Wound on buttock healed up slowly.

22nd April.—No chorea now except when she smiles; she then grins and looks nervous in her movements. Sleeps and eats well. Industrious and rational. Has only gained 2lbs. in weight in a month. M. T. 98.4°, E. T. 98°, M. P. 96, E. P. 84.

Her recollection of the coming on of the disease is imperfect, and she has no remembrance of the choreic movements beginning. Her mind must have been affected quite simultaneously with their appearance or before them. She does not even recollect the rheumatic pains going away. She says that she had no conscious feeling of weakness or exhaustion from the nursing before the rheumatism began. Her recollection of events which occurred during the first month of her illness is most imperfect.

26th April.—During the past week has gained five pounds in weight, and is now cheerful, rational, and says she feels perfectly well. Muscles under her control.

T. F., admitted 1st Feb., 1870, æt. 19, single. Apprentice to a boiler-maker; can read and write; Church of England; from Carlisle.

History.—First attack of insanity. Father died of traumatic tetanus. Mother, brothers, and sister alive and well. No near relative insane or rheumatic; but mother nervous and maternal aunt eccentric. He was a quiet lad of steady habits. The predisposing cause of his illness seems to have been two attacks of chorea which he had; one at the age of seven, caused by a cold, and which lasted six days; and another at

the age of thirteen, of a more slight character. His mind did not seem to have been affected at all during those attacks.

The exciting cause of his illness was an attack of acute rheumatism, which had lasted for three weeks before admission; had been preceded for a week by a severe catarrh, and had been caused by exposure to cold one night after being heated with work inside a boiler.

He was feverish, and had much swelling and pain of wrists and feet, but no heart symptoms. He had a remission, and during this, when he attempted to read, had bright dots before his eyes. Six days before admission choreic movements began in left arm and leg, and although no particular mental symptoms were noticed at first, except a strangeness of manner, restlessness, and inattention to things going on round him, yet the insanity must be put down as dating from that time, as now when he is well he has no recollection of anything that occurred from that time. He cannot remember the jerking movement of his limbs at all, though up to that time he remembers all that occurred. He still complained of pain in the joints affected with the rheumatism from the choreic movements, but in two days he became much excited in mind, ceased altogether to complain of the pain in his wrists, and the swelling got rapidly less. He insisted on getting out of bed, and attempted to throw himself out of the window. He imagined his mother was going to poison him. The choreic movements got much worse. He was violent, and attempted to bite those who restrained him. The swelling of his wrists gradually got less after the chorea commenced, after which he scarcely ever slept. He began to take his food much better after the mental symptoms appeared than before.

State on admission—Mental.—He was much excited, quite confused, and incoherent, can't remember anything, or answer questions, and evidently has suspicions of persons round him.

Bodily.—He is a thin, rather over-grown looking lad, of fair hair and complexion, looks pale, and his muscles are flabby. About 5ft. 11in. He throws his arms about continuously in a most extraordinary way, his head jerks from side to side, and his facial muscles are in constant action, giving him a most extraordinary appearance; he walks unsteadily and with difficulty, the muscles of his legs being imperfectly under his control. Reflex action in right leg gone, and much

diminished in left. Sensibility somewhat impaired in both legs. Pupils equal, lungs normal, heart's action tumultuous, but no abnormal sounds. Tongue white, furred, and projected out with a jerk, and unsteady. Takes food. Left wrist swollen, but only slightly tender. Urine acid, no deposits. Sp. gr. 1030: M. T. 101.1°, E. T. 100.6°. P. 120. Weight 149½lbs. Put to bed in padded room.

Progress of Case.—He did not sleep the first night, but kept his bed the next day, the chorea not being quite so bad. Took food, but seemed suspicious of it. To have beef tea and 4oz. wine extra to diet. M. T. 99.6°, E. T. 100°, M. P. 96, E. P. 112. Swelling of wrist subsiding, confused and stupid in mind, not so excited.

4th Feb.—Sleeps better, more rational, can answer questions, but is still confused. Cheeks flushed. Tongue clean. Bowels costive. To have castor oil. Right pupil slightly larger than left. M. T. 99.2°, E. T. 100°, M. P. 108, E. P. 100.

Feb. 8th.—Still confused in mind. Imagines it to be a different day of the week from what it is, and will not believe when told what day it is, and affirms it is the 29th January (the day after he became affected in mind). He wants to be sent to gaol. Imagines the people about him watch and annoy him. Choreic jerking gone from all but left hand and arm, and tongue. Pupils equal. Temp. down. M. T. 98.4°, E. T. 99°; pulse 96.

Feb. 20th.—Has hallucinations of vision. Says he had a vision of hell, and wants to commit suicide; looks still confused, suspicious, and frightened. Won't believe what he is told. Sometimes refuses food, saying it is poison; that it tastes like poison. Fancies that he is a prisoner here, and is closely watched, and that he is quite different from the other people. M. T. 98.4°, E. T. 98.6°, M. P. 96, E. P. 96.

March 10th.—Mind clouded, memory impaired. Sleeps well. Twitchings of tongue still, and some crankiness of legs. Can't stand and look to ceiling without at once becoming giddy, and would fall.

March 31st.—Delusions now gone, memory returned. Talks rationally about his illness. Still slight twitchings of tongue, which he generally puts out to right side. There is a certain unsteadiness in the way he puts down his feet. Can carry things steadily with arms and hands. He still cannot read a book for more than a few minutes at a time, on account of "sparkling dots" passing before his eyes. Has begun to gain in weight. M. T. 97.2°, P. 66, much stronger.

April 16th.—When he speaks there are still slight twitchings of edges of mouth. Tongue unsteady. Gait still not firm. Is regaining the elasticity of mind and good spirits one would expect in a young man.

April 23rd.—Seems now quite well in mind, and has lost all traces of the chorea. Can, for the first time, stand steadily on one leg, and look up to the ceiling. Can read without seeing the dots. Laughs about his former delusions. Memory of events which occurred during his illness very dim. Is gaining three pounds a week in weight. M. T. 98.2°, E. T. 98.4°, M. P. 76, E. P. 66.

April 25th.—M. T. 97.8°, E. T. 97.6°, M. P. 84, E. P. 66; weight 156lbs.

Remarks.—I have called the above cases Rheumatic Insanity instead of Choreic Insanity, because I regard them both as clearly caused by the rheumatic poison. Rheumatism as a cause of insanity had been mentioned by several writers previously, but Griesinger directs special attention to acute rheumatism as one of the rare causes of insanity, and gives two cases, one in his own practice and the other quoted from Flemming.*

He thinks that mental disorders should not be considered as the mere sequel or accidents of convalescence in rheumatism, as in fevers; but "They are only a protracted form of that cerebral affection appearing in various forms, and in its acute development often so very dangerous, which frequently appears in acute rheumatism, either simple or complicated with cardiac inflammations, which leaves behind it no definite anatomical changes, and therefore is most conveniently designated rheumatic cerebral disorder." He mentions, as among the symptoms in different cases, acute delirium, coma, melancholia with stupor, mental weakness, and says that these are "sometimes associated with chorea attacks." He also mentions the articular affections as frequently disappearing when the mental symptoms begin, the former again reappearing when there is a remission of the latter. The first of his cases was that of a woman who had been insane previously, some years before, who had acute rheumatism, was at first maniacal, then depressed with stupor, and when the mental state improved the joints again became swollen and painful. She had a slow convalescence of three months. He specially mentions the absence of feverishness during the men-

* Griesinger, "On Mental Diseases." New Syden. Soc. Trans., p. 188.

tal attack, and says nothing at all about chorea. In his second case the rheumatism was more chronic, and as the pain and swelling of the limbs disappeared the patient "began to complain of drawing pains along the spine, restlessness, and stretching, and having occasionally jerking movements in the extremities. In a few days mental depression appeared, which increased, assumed the form of apathy, and finally of complete insensibility." Nothing is said about feverishness, and the length of time occupied by convalescence is not mentioned. The patient recovered.

Trousseau goes very fully into "Cerebral rheumatism,"* and treats also of the almost constant connection between chorea and impairment of the intellectual faculties,† and of the connection between chorea and rheumatism. As regards the first, he says that "articular rheumatism has no great tendency to develope cerebral manifestations;" and that there are six forms of cerebral rheumatism, viz.:—1, the apoplectic; 2, the delirious; 3, the meningitic; 4, the hydrocephalic; 5, the convulsive; and 6, the choreic: all of which he regards as "an expression of the same cause, and of the same anatomical lesion, if there be one; and they no more deserve to be regarded as distinct species than the delirious or convulsive form of typhoid fever or scarlatina." He quotes, with approval, Dr. Sée's opinion that chorea is merely a special manifestation of rheumatism.

Sanders relates five cases of a somewhat similar kind to those I have mentioned;‡ but he expressly says there was no fever (it is not stated that the thermometer was used), and the choreic movements are not much dwelt on. They only occurred in some of the cases.

M. Thore relates a case in which chorea appeared during an attack of acute rheumatism with endocarditis and pleurisy, and in two days alarming mental symptoms, hallucinations of sight, hearing, and touch followed.§

Of English writers, Dr. Bright, Sir Thomas Watson, Dr. Latham, Dr. Burrows, Dr. Todd, Dr. Fuller, and Dr. Chambers have related cases where cerebral symptoms have appeared in acute rheumatism.

Then the occasional occurrence of simple chorea as a sequela of acute rheumatism is well-known. A very generally received explanation of this is that of Dr. Hughlings

* Trousseau's Clinical Medicine. Syden. Socy's. Trans., vol. i., p. 513.
† *Ibid*, p. 386. ‡ Zeitschrift f. Psychiatrie, 1863, p. 214.
§ Ann. Med. Psychologiques, 4th serie. T. v., p. 157.

Jackson, viz., that small particles of fibrinous matter get detached from the roughened valves of the heart, and cause embolisms in the spinal cord.

In the last number of the "Journal of Mental Science," in the admirable abstract of German psychological literature by Dr. Sibbald, mention is made of the views of Dr. Arndt on the relation between chorea and mental affections. He says there are cases in which the most extensive mental disorder is evinced by movement. "He regards both the physical and mental symptoms as proceeding from the same cause, and presenting many analogies. He does not believe in the existence of chorea without more or less simultaneous affections of the intellectual faculties. The abnormal movements are mere symptoms of a much more extensive disorder, involving the entire nervous system, and never confined in their effect to the spinal cord. The so-called pure chorea, in which mental symptoms are said to be absent, but in which they are in fact only feebly manifested, is really the mere forerunner of a fully pronounced psychosis. But just as every morbidly depressed emotion and every morbid exaltation of consciousness does not necessarily lead to melancholia, mania, or dementia, so neither does chorea."

Dr. Maudsley describes the mania of chorea as of a peculiar character, accompanied by utter incoherence of ideas and entire inattention to anything going on around the patient. He thinks that this perverted psychical state is analogous to the disjointed and irregular movements, and seems to result from each group of cells acting by itself without reference to the usual co-ordination of all the nervous ganglia.

Taking those facts and those theories into consideration, is any light thrown on the relations between rheumatism, chorea, and insanity, or on the connection between motor and psychical abnormality, by the two cases I have related? Was the rheumatism the true cause of the mental symptoms, of the chorea, or of both? Were these abnormal affections of motion and the perverted psychical manifestations the result of an identical and simultaneous lesion affecting both the motor and mental ganglia? Or was the one dependent on the other, secondary to it, or sympathetic with it? Is it probable that in those two cases we have a distinct form of insanity, a form about which much may be ascertained by a careful study of its relation to and its co-relation with the motor symptoms? May not even the great general question of the connection between

mind and brain—that question of questions for us as students of brain disease with mental symptoms—receive some elucidation from the careful study of two such cases, in which the varied functions of the nervous system, the nutrition and heat of the body, the power of motion, of sensation, and of reflex action, the special senses, the memory, and the intellectual processes were all affected at the same time, and recovered their normal action about the same time? Is it not probable that the study of some such rare and peculiar and universal lesions of the cerebro-spinal nervous centres may yet prove the key to many an unsolved question in psychology, and may do more to place the study of mental aberration on a true basis than anything else? Should we not eagerly look out for cases, therefore, where there are causes or symptoms, or pathology which are definite and tangible, and which we can study in relation to other better known diseases? Such questions are my excuse for having entered into those two cases at so great a length, and for the length of the observations which follow.

I think it cannot be doubted by any one that the rheumatism was the true cause both of the chorea and the insanity in these cases. The likeness of the one to the other in nearly all their symptoms, in the coming on of the disease, in the choreic movements, in the paralysis of motor power, in the deadening of reflex action of the legs, in the hallucinations of sight, touch, and taste, in the want of memory, in the acute delirium with unconsciousness of anything going on around, succeeded by confusion of ideas, suspiciousness, and sluggishness of mind, the high temperature increased at night, the tendency to improvement in all the symptoms coincidently with the lowering of the temperature, and the slowness of the convalescence in both — all these things show that the same kind of lesion of the nervous system existed in both. And when this is taken along with the fact that in both patients this train of symptoms suddenly appeared in the course of an attack of rheumatism, that in both the symptoms of the articular rheumatism at once disappeared, while the fever *did not do so*, and that in the woman, when she was nearly well, rheumatic swelling of the knuckles of one hand appeared along with aggravated choreic movements, sleeplessness, and an increase of temperature, we have very strong data, not only to conclude that rheumatism was the cause of those symptoms, but that here we have true and typical examples

of a rheumatic insanity, which must be classed by itself as a special form of mental disease—a true pathological entity.

As to how the nervous system was affected, may we not form a probable hypothesis? We know how the rheumatic poison, whatever it is, affects the other tissues. We know also something of the kind of lesions of the spinal cord which are needed to produce paraplegia and the total absence of the power of the reflex action, even if we do not know so much of the pathology of chorea and insanity. In regard to the motor affection of the legs, we saw that at first there was violent choreic movement, which was succeeded by complete paralysis of motion, no power of reflex movement, and greatly diminished common sensibility. As the power of motion returned, which was in the course of a few days, there was hyperæsthesia and a sensation of heat. Does not this sequence of phenomena indicate a serious but transitory interference with the functions of the nerve-cells and fibres in the spinal cord, such as might be produced by slight rheumatic inflammation and infiltration of the connective tissue of the cord, causing pressure on the nerve elements? If the nerve-cells or fibres had been themselves attacked with any inflammatory affection, they would not have so soon regained their function. We know the rheumatic poison has a special tendency to affect the connective tissue. The rheumatic pains in the limbs are caused, we cannot doubt, by simple pressure on the small nerves. And if the cord was affected in this way, can we doubt that the same thing took place in the ganglia that minister to special sensation, and also the great hemispherical ganglia? The raised temperature, the strongly acid urine, remained the same, whether the rheumatic inflammation was in the joints or in the central nervous system. But when the inflammation had passed away, the effects were far longer visible in the delicate tissue of the nervous centres. That all the cerebro-spinal tract was affected simultaneously in those cases is shown by both patients not now remembering anything that occurred from the time the choreic movements appeared, though for the first day or two intelligence did not seem to be abolished.

In both cases the insanity might be described as a metastatic one, if such a term were strictly applicable to the effects of a poison in the blood whose effects are first seen in one set of tissues, and when it attacks another set the effects in the former cease. The slight relapse in the woman, where the hand and the spinal cord were both affected at the same time, showed, however, that the effects of the toxic agent need not

be absolutely limited to one sort of tissue. If we believe this theory, that of embolisms falls to the ground, as an explanation of the chorea of rheumatism with or without mental symptoms. There was no trace of a tendency to heart disease in either case. The effects of embolism could not have so soon passed away, even if it is conceivable that it could have been universal in all parts of the brain and cord.

It would seem that in such a lesion of the spinal cord as occurred in those two cases the common sensibility was the last to be abolished and the first to come again; then the voluntary motor power, then the reflex action, and last of all the power of the nerves which preside over nutrition. That the sensory and motor powers should have been less interfered with than the reflex action is what might have been expected, when we consider that the greater number of the nerve-fibres ministering to the two former functions merely pass *through* the cord, while the more delicate nerve-cells forming the ganglia which subserve the latter function, lie *in* the cord itself, and the cord was evidently more affected than the brain.

It was not until all the other functions were restored that the patients gained in weight rapidly. The slough that formed over the buttock from the bruise, and the slow healing of the wound, showed how much the nerves of nutrition were affected at first. In regard to the special senses, sight was first affected, and then taste, and they were restored in inverse order. Of the purely psychical functions memory and the power of voluntary attention were first affected, then the coherence and balance of the mental powers was upset, and lastly the whole of the mental operations were merged in the acute delirium and utter incoherence present. Curiously in both patients there were suspicions of those about them, and entire scepticism as to what they were told about the most simple matters during convalescence. Yet there was never in either of them any tendency to mistake the identity of any one about them, and one of the very first mental acts they both performed correctly, was to take notice of persons about them, and know them again when they saw them. The healthy elasticity of mind and enjoyment of life, which is the most certain proof that the brain is performing all its functions normally, was the last to return, and corresponded to the restoration of function of the nerves of nutrition, and the commencement of a rapid increase in weight of the whole body.

I am aware that the high authority of Trousseau is rather

against my theory of rheumatic inflammation of the connective tissue of the cerebro-spinal centres. He says that no anatomical lesions have been found in the most severe cases after death; but both Sir T. Watson and Dr. Fyfe report cases in which severe lesions were found; and, considering the short time which has elapsed since the very existence of the *bindegewebe* in the nervous centres was discovered, taking into account its small amount and delicate structure, and demonstrated oneness with the connective tissue in the rest of the body, it seems not too great presumption to oppose his strongly expressed opinion in this matter. His opinion was against rheumatic inflammation of the *membranes*, and he was probably right. The connective tissue of the cord might well be slightly affected with a rheumatic inflammation, and yet the membranes be quite intact. He refers to the examples of ordinary chorea, of tetanus, and of hydrophobia, where the utmost interference with all the normal functions of the brain and cord has taken place, and yet no inflammation or other obvious lesion is generally found after death, and asks why, therefore, is it necessary to suppose that such lesions exist in cerebral rheumatism? The difference is obvious. In those affections there is no increased heat; in the rheumatic insanity we have seen this to exist as an essential part of the symptoms, and to be aggravated with any aggravation of the nervous symptoms. It does not appear that Trousseau knew this, or took it into consideration. If there was one point of striking importance and interest in those two cases it was the increased temperature; and I am not aware that attention had been directed to this by anyone before. It affords another example of the immense importance of the use of the thermometer.

It will have been observed that I used almost no treatment in those two cases, except abundant diet and alcoholic stimulants, because in the first place I had never seen such a disease before, and did not know how to treat it, and in the second place I was anxious to let them run their natural course, so that the effects of treatment in future cases may be more certainly known.

OBSERVATIONS AND EXPERIMENTS

ON THE

USE OF OPIUM, BROMIDE OF POTASSIUM, AND CANNABIS INDICA IN INSANITY,

Especially in regard to the effects of the two latter given separately.

By T. S. CLOUSTON, M.D.,

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So many cases of insanity consist of simple brain excitement, and in so many more is excitement the most distressing symptom, that if we could discover any agent which would subdue this excitement, and at the same time not interfere with the improved nutrition of the brain which rest, tonics, and good diet will effect, and on which complete recovery of its normal functions depends, such an agent would be a most incalculable blessing. There are many cases in which a physician knows that if he could tide over his patient for a few weeks of excitement, that recovery would come as the natural termination of the attack. Much distrust of strong narcotics prevails among the profession since Dr. Anstie's work on 'Stimulants and Narcotics' appeared. And yet how is such a case of maniacal excitement to be managed without them out of a lunatic asylum? The exact condition of the brain cells in mania being as yet quite unknown, we cannot apply a direct antidote. At best we can only work very empirically. But our empiricism may be founded on a rational and scientific examination of the effects of the drugs we use, and the natural history of the disease we treat, or it may be a mere haphazard employment of some agent recommended by some one who had no rational ground for his recommendation at all. Maniacal excitement is so essentially in many cases what has been hitherto called a functional disease, that it offers more hopes of benefit from drugs than most other complaints. A patient is rational and coherent in mind one hour and is furiously maniacal the next, and the excitement passes off as quickly. Surely such a condition may be reached and remedied by some therapeutic agent. We have many drugs more or less "narcotic" and "sedative," but hitherto the effects of those drugs have been far more carefully studied when given to persons previously free from excitement, than when given to those acutely maniacal. I do not mean to undervalue the observations which have been made on this subject, but all physicians know and strongly feel the want of accuracy and definiteness which prevails in this department of medicine. The following observations were undertaken almost entirely with the view of obtaining a little more accuracy in my own knowledge of the effects of certain medi-

[1] *The Essay for which the Fothergillian Gold Medal for* 1870 *was awarded by the Medical Society of London.*

cines on maniacally excited patients. They consist of two parts: the first, experiments made chiefly on incurable patients in whom simple brain excitement existed; the second, clinical observations on the effects of the same medicines on recent and curable cases of excitement. The experiments were undertaken to show, first, the effects of single doses, and second, the effects of long continued courses of the medicines.

The action of the bromide of potassium in cases of maniacal excitement especially deserves careful study. It acts differently in many respects from most of the vegetable narcotics. Given along with at least one of them, it seems to intensify and prolong its effect on the nervous system, without at the same time affecting injuriously the digestion and the nutrition of the body. The investigation of this point will be one special object of this paper.

The action of opium on disordered function of the cerebrum is better known than that of any other drug, though very much remains to be accurately ascertained. So much confusion exists as to its physiological action on a healthy subject, and its therapeutic action on a diseased one, so little is really known as to the tolerance of the remedy in certain disorders of the brain, there has been such a tendency to apply Dr. Anstie's theory as to the identity of narcosis and brain paralysis, where it is quite inapplicable, that any carefully recorded facts bearing on any part of this subject must be of value. Then the action on the healthy brain of a pure stimulant, such as whisky, has been carefully studied, but observations on the tolerance of large doses of such a stimulant in disordered brain functions are much needed. Any effect which food has in such cases we are accustomed to regard, and I believe truly, as beyond question directly towards health. To compare the effects of these various drugs with the effects of a highly concentrated food, therefore, on a given number of cases of brain disorder, can scarcely fail to be instructive.

Effects of single doses.—To ascertain the effects of single doses I at first selected eight patients (four men and four women), all labouring under great excitement, and from two hours and a half to three hours after breakfast, after taking their pulse and temperature and noting their mental state, I gave to each of them the dose of the drug or stimulant I was experimenting with. They were then sent out in the open air, from which they had been taken in, except the day was very cold, and in that case they were kept in the house, and in an hour I again took their pulse and temperature, and noted their mental state. Their condition during the afternoon was also observed. The next day I gave another drug, and this was continued till all had been gone over, when I began again, repeating the experiment four times, with most of the substances used, and twice with the others. I gave these patients in this way drachm doses of tincture of opium, drachm and two drachm doses of bromide of

potassium, drachm doses of tincture of cannabis Indica ('British Pharmacopœia'), and a mixture containing one drachm of bromide of potassium, and one drachm of tincture of cannabis. I performed the same experiments, only instead of the medicine giving each patient four ounces of good Scotch whisky one day, and a pint of beef tea made from a pound of good beef another. I made experiments on myself and my assistant, using smaller doses, and not repeating them so often.

The reason I did not keep the patients in the house in a room of a uniform temperature was, that I wished to see the effect of the various substances on them in their ordinary circumstances at that hour. Two of them I did keep in a bedroom of uniform temperature during most of the experiments, but I found that this did not materially alter the results. I was not able to continue the experiments on all the patients continuously, on account of some of them being free from excitement on certain days, and other causes. On such days I usually substituted other patients who were also excited. They laboured under the most various forms of mania, but the element common to all of them was great excitement and disorder of the functions of the brain. None of them laboured under any bodily disease.

My objects were to ascertain accurately the effect of single doses of each medicine on, 1, the maniacal excitement; 2, the appetite; 3, the temperature; 4, the pulse, and to compare them with each other, and with the effect of a pure stimulant in large doses, and the most concentrated and nourishing of food. It is not surprising that I found the results with each drug were not the same in each patient in the successive experiments. A maniacal patient is so changeable and uncertain in his state with or without medicine, he varies so much as to the amount of muscular exercise he takes, and his whole system is so affected by these variations, that one cannot wonder at anomalies in the experiments on particular days. It was to obviate these uncertainties as much as possible that I took so many patients labouring under various forms of excitement, and repeated the experiments so often. In that way, I think, the results may be re-

TABLE I.

Substances given.	No. of Patients.	No. of Experiments.	Excitement aggravated at first.	Excitement subdued.	Excitement not subdued.
Tinct. Opii	9	29	2	19	10
Potas. Bromid. and Tinct. Can. Ind.	8	29	5	26	3
Potas. Bromid.	7	13	0	7	6
Tinct. Can. Ind.	7	15	0	12	3
Whisky	10	21	13	14	7
Beef tea	9	15	0	1	14

garded as trustworthy as to the *general* indications they give. I shall endeavour now to summarise the daily observations which I made.[1]

Excitement.—The effect of any medicine on maniacal excitement cannot be at all so exactly measured or defined as its effect on the temperature or pulse. The general and decided effects of the drugs I gave I have shown in Table I. From this it is seen that the combination of bromide of potassium and tincture of cannabis subdued the excitement in the greater number of cases, and certainly its effects were more patent and lasting than any of the others. Of the twenty-nine times in which it was given it decidedly subdued the excitement on twenty-six occasions, or in 90 per cent. of them. Opium was the next drug in potency of effect, though it only subdued the excitement in nineteen of the twenty-nine experiments, being 66 per cent. The bromide of potassium alone allayed excitement in about one half the experiments in which it was used, but its effects were very much less decided in the extent to which it allayed the excitement. Its effects usually lasted, however, for the remainder of the day on which it was given. In one half of the experiments two drachms were given, and this dose it was which had the effect on the excitement in five of the seven experiments in which any effect was observed. The Indian hemp produced abatement of the mania in twelve out of the fifteen experiments, but in almost all these cases its effects were comparatively slight, and seldom lasted for more than three hours. The whisky was followed by marked cessation of the excitement in fourteen out of twenty-one experiments, and its effects, contrary to what might have been expected, lasted usually for seven or eight hours. The beef tea had no appreciable immediate effect on the maniacal excitement in most cases. In only one case did a patient become more free from excitement after getting it, and this was the weakest of the number.

In regard to the length of time each drug took to act, and the mode of action of each, I found that the sedative effect of the opium was got most speedily. Aggravation of the excitement previous to the sedative effect was observed five times in the case of the mixture of the bromide and cannabis Indica, twice in the case of opium, and thirteen times in the case of the whisky, and this aggravation was so great and troublesome in the case of the last as to put it out of the question as a sedative for maniacal excitement. The sedative effect usually began to appear in from half an hour to two hours after the mixture of bromide and cannabis Indica, though in some of the experiments this was delayed for three hours. The preliminary stage of aggravation, when it occurred, lasted for about two hours in the case of the drugs, and for about one hour and a half in the case of the whisky.

[1] The daily records themselves were appended to the original essay, but they are too long for insertion here.

It was only the milder cases which were affected by the bromide or the cannabis Indica separately ; the opium and whisky affected some of the worst cases at times, while the combination of the former affected the most excited on the largest number of occasions.

A very striking fact is seen at a glance at the records of the observations themselves, and it is the extreme *uncertainty* of action of almost all the medicines on successive days on the same cases. One day the drachm of Tincture Opii subdued the excitement and caused no loss of appetite. Another day in the case of the same patient the same dose was followed by no such effect at all. It is this which renders any such therapeutical inquiry so apparently unsatisfactory, but which gives additional value to any drug whose effects are most free from this element of uncertainty. It shows how many things have to be taken into account, and how very many accurate observations will have to be made before anything like reliable generalisation can be attempted. We can only at present follow the *prevailing tendencies* of action of a drug.

In none of the experiments, even when the patient was most fully under the influence of any drugs, was there anything like a narcotic action. The nearest approach to this was the drowsiness and sleep that sometimes occurred. But it seemed quite natural sleep. It would surely be a misnomer to apply the word "paralysis" to any result of those drugs in these cases. If an acute maniac is talking incoherent nonsense and moving about incessantly, his reasoning powers and intelligence being in abeyance, and if after a dose of bromide of potassium he ceases to talk and move about so much—all the other functions of the nervous system being undisturbed—and he makes some nearer approach to reason or intelligence, we must find some other name than either "narcosis" or "paralysis" for such a result. Dr. Anstie implies that the effect of a large dose of opium on maniacal excitement must be "narcotic." In the cases above related, the action was truly "stimulant" in his sense, though the doses were "narcotic doses."

As regards the food action on the excitement, it was in all these cases so inappreciable at the time that no comparison can be made

TABLE II.

Substances given.	No. of Patients.	No. of Experiments.	No. of times appetite taken away.
Tinct. Opii	9	29	7
Potas. Bromid. and Tinct. Can. Ind.	8	29	1
Potas. Bromid.	7	13	0
Tinct. Can. Ind.	7	15	1
Whisky	10	21	1
Beef tea	9	15	0

between it and the drug action as regards immediate effect on the excitement.

Appetite.—No effect of a drug is more important on a maniacal patient than its effect on his appetite for food. If that is much interfered with, the good effects of the medicine will have to be great and manifest indeed, to counterbalance so indisputable an evil.

I have in Table II shown the number of times in which the patient's desire for food was clearly interfered with after each medicine given. Opium stands in bad pre-eminence at the head of the list as that which most frequently produced this result. In seven out of the twenty-nine experiments with opium, the patients could not be got to take the next meal. This was never the case after bromide of potassium at all, and only once after cannabis Indica and its combination with the bromide. This was one of acute excitement, with complete incoherence and absence of reason, being that most like the acute delirium of fever. In his case it caused on two occasions dryness of the tongue and lips as well as loss of appetite.

Temperature.—The temperature of the body in maniacal excitement has been far too little attended to. It often rises in a direct ratio to the brain excitement present, it is most important as a diagnostic of organic disease, and it affords most valuable indications for treatment in many cases. In Table III I have recorded the results of my observations in regard to temperature. The tendency of opium was to raise the temperature slightly; that of the bromide and cannabis Indica combined to depress it; of the bromide alone to raise it rather more than opium; of the cannabis Indica alone

TABLE III.

Substances given.	No. of Patients.	No. of Experiments.	Average Temperature.		Average gain in each experiment.	Average loss in each experiment.
			Before medicine.	After medicine.		
Tinct. Opii . . .	9	29	97·6°	97·8°	·2°	...
Tinct. Can. Ind., Potas., and Bromid.	8	29	98°	97·7°	...	·3°
Potas. Bromid. . .	7	13	98·1°	98·4°	·3°	...
Tinct. Can. Ind. . .	7	15	97·5°	97·6°	·1°	...
Whisky . . .	10	21	97·9°	97·3°	...	·6°
Beef tea . . .	9	15	98·16°	98·14°	...	·02°

to raise it very slightly; of the whisky to lower it most of all, and of the beef tea to lower it in the most trifling degree possible. It must be remembered that the temperature of the body in such maniacal patients is higher than in health. I think we must look on the action of opium, bromide of potassium, and tincture of cannabis, therefore, in this respect, as being away from the healthy

standard, while that of a mixture of the bromide and tincture of cannabis is in the opposite direction. There can be no doubt about the lowering of temperature caused by the whisky being too great. Its effect in this direction was almost uniform in nearly all the experiments. Even when it aggravated the excitement at first, and there was much more muscular motion, the temperature was usually found lower. A loss of 2·3° in the temperature of the body in an hour (when that temperature had not been very abnormally high to begin with) means devitalization, and that was the case once after the whisky. We may fairly in this case, then, take the effect of the beef tea as our standard of what we might expect from a drug which most readily approached the reparative action of food. The effect of opium was in the wrong direction altogether; that of the mixture of the bromide and cannabis Indica in the right direction, but perhaps going too far; and of the whisky in the right direction, but going too far.

The different effect of the mixture of the bromide of potassium and the cannabis Indica from each of them given separately is worthy of notice, as it confirms my experience that in all respects this mixture acts differently from either of its constituents.

The effects of smaller doses on my assistant and myself differed from those above mentioned in the bromide lowering the temperature, the cannabis Indica raising it considerably, and the mixture of both raising it very slightly, while the beef tea also raised it slightly. The lowering of the temperature by whisky was very marked.

TABLE IV.

Substances given.	No. of Patients.	No. of Experiments.	Pulse before getting medicine.	Pulse after getting medicine.	Average gain in each experiment.	Average loss in each experiment.	No. of times pulse decidedly irregular, or intermittent.
Tinct. Opii .	9	29	85	84	...	1	3
Potas. Bromid. and Tinct. Can. Ind.	8	29	84	95	11	...	7
Potas. Bromid.	7	13	83	79	...	4	1
Tinct. Can. Ind.	7	15	83	89	6	...	3
Whisky . .	10	21	81	82	1	...	0
Beef tea . .	9	15	80	79	...	1	0

Pulse.—In Table IV the effects of the different substances on the pulse are seen. That of opium was to lower it to a most trifling extent. The bromide did so in greater degree, and the beef tea about the same extent as the opium. The tincture of cannabis Indica, on the other hand, caused an average increase of eleven beats, and the tincture of cannabis alone of six beats. The tendency of the mixture was also slightly to lessen the force of the pulse; and as is seen from

the table, to cause irregular action to a greater extent than opium. In seven of the twenty-nine experiments an irregular or intermittent pulse followed a dose of this mixture, while in only three of the twenty-nine was this the case after opium. It is known that cannabis Indica quickens the action of the heart; but why the bromide, which itself tends to reduce its action, should actually strengthen the accelerating action of the cannabis, is only explicable by the theory that all the effects of the latter are greatly added to by giving it with the former.

On myself and my assistant the effects of smaller doses on the pulse were the same as the results shown in the table.

Taking all the effects of these medicines into account, I think the balance of good is decidedly on the side of the mixture of bromide of potassium and cannabis Indica. The greater certainty and longer duration of its sedative effect on the excitement, and the absence of any bad effect on the appetite, are good results which are not materially interfered with by its action on the heart.

In regard to the dose of bromide of potassium, which is equivalent in sedative effect to opium or henbane, it is very difficult indeed to come to an exact conclusion. If there is much excitement, no single dose of the bromide up to two drachms will be at all equal to one drachm of the tincture of opium. To produce sleep in milder cases my experience is, that one drachm of the bromide will have the same soporific effect in most cases as half a fluid drachm of laudanum, or two drachms of the tincture of hyoscyamus. With regard to the dose of a mixture of the bromide and tincture of cannabis, which will be equivalent to laudanum, I have had more experience. The experiments as to single doses throw some light on this, and in many other cases I have given the two medicines alternately to see the effects; while in others, to whom I now give the bromide and tincture of cannabis to allay excitement, I used formerly to give opium, hyoscyamus, and tincture of cannabis alone. In only two out of thirteen cases did I find one drachm of the bromide with one drachm of the tincture of cannabis to have a less sedative effect than one drachm of tincture of opium. In two cases its effect was about the same, and in the other nine it was unequivocally more decided, while in two it was more decided than ninety minim doses of the laudanum. My experience has been, that about forty-five grains of the bromide, along with forty-five minims of the tincture of cannabis, will have the same sedative effect as a drachm of laudanum. In one violent case of periodic mania, with whom opium did not agree, I find that drachm doses of the bromide, and a drachm of tincture of cannabis, have rather more than the same effect as half-ounce doses of the tincture of hyoscyamus, and that by adding drachm doses of the bromide to one drachm of the tincture of hyoscyamus, the same sedative effects were produced, or by half-ounce doses of the latter alone. In another

case drachm doses of each of the bromide and cannabis have as much effect as six drachms of the tincture of hyoscyamus. In another case half-drachm doses of each of the former have about the same sedative effect as two-drachm doses of the latter.

The experiments with single doses which I have related quite bear out my previous experience as to the decided increase in the effect of a combination of the bromide and the Indian hemp over the effect of either of them used separately. Over and over again I have found that half-drachm doses of each were more powerful than drachm doses of the tincture of cannabis, or than two-drachm doses of the bromide. This seems to me one of the peculiarities of the bromide of potassium, that, combined with a sedative drug, it powerfully increases the usual effect of such drug. I cannot speak so certainly of this effect when combined with opium, but with hyoscyamus and Indian hemp it is most decided. In my own case, the effect of fifteen minims of tincture of cannabis along with half a drachm of the bromide was very much stronger than half a drachm of the former alone, and incomparably stronger than a drachm of the latter. In very many cases I have given a combination of the two medicines where I had been giving sometimes the one and sometimes the other previously, and I have always found that half quantities of each combined were as powerful as double the amount of the cannabis, and more powerful than double the amount of the bromide given alone.

It was one of the effects of Indian hemp specially mentioned by O'Shaughnessy in his first experiments with the drug, that it caused an increase of appetite, and I found that when giving the bromide of potassium to my epileptic patients, it increased their appetites. Certainly no sedative or narcotine drug that I have ever used in large doses in the case of maniacal patients affected their appetites so little as the two given together. In doses under a drachm of each I never saw any diminution of appetite at all, and in large doses it was only after a long time that I found the appetite sometimes lessened.

My own experience of the kind of effect produced by mixture of the bromide and the Indian hemp as distinguished from the effect of each of those taken separately when I took them myself was this. Half a drachm of the bromide produced a slight drowsiness in about an hour, which lasted for about two hours, but the effect was almost imperceptible. A drachm of the bromide produced a more decided drowsiness, and after about two hours a feeling of coldness and slowness of the pulse. Half a drachm of the tincture of cannabis produced in an hour a feeling of confusion and fulness in the head, then a sort of preternatural acuteness of hearing, then the impression of a great length of time between acts performed within a minute of each other described by Christison, and in two hours great drowsiness,

which lasted for four hours, leaving a feeling of confusion in the head and incapacity for continuous mental exertion. Fifteen minims of the same tincture along with half a drachm of the bromide, caused in an hour first a tingling in the calves of the legs, then numbness of the legs extending gradually all over the body, then confusion of ideas and the impression of lengthened time and sense of fear, then a tendency to jerking and unsteadiness of the muscles. In about two hours all these sensations became merged in a sensation of fulness in the head and great drowsiness, which lasted for six hours. Its effect was also strongly diuretic. It produced quickness and irregularity of the pulse for the first three hours. I do not attach very much importance to the experiments on myself and my assistant, as no true comparison can be made between a therapeutical and a purely physiological experiment. Curiosity alone prompted me to take the drugs myself.

Effect of the sedatives when given regularly for long periods.—Opium in large doses having been hitherto regarded as the most powerful, and in the majority of cases the most reliable sedative in uncomplicated maniacal excitement, I selected nine chronic maniacs, all labouring under great excitement of long duration, and on them tried the effect of opium given continuously for a length of time. I knew the natural history of the disease in them all, for they had all been under my observation for periods of from three to five years, with little or no medical treatment for long periods. I regarded them all as quite incurable. Whatever effects on the bodily health and organic functions the brain excitement could produce, had taken place, and they were nearly all, as it were, *in statu quo* as regards body and mind. I had no reason to suppose that any of them had such organic disease of the brain as softening, tumours, or any other progressively fatal lesion. In three of them there were remissions of the excitement at regular times, but the periodicity in each of them was regular and quite well known to me. My reasons for taking such cases were, first, that they were incurable, and therefore the experiment could not do any harm to them; second, that in them I had simple brain excitement in known amount, against which I could, as it were, match a sedative drug; and third, that in them I could observe the effects of that drug on the bodily functions, the temperature, the weight of the body, the pulse, &c., with the certainty that any changes that might occur were the effects of the drug, and were not happening in the natural course of the disease.

For a month I had these patients weighed every week, noting their weights, their morning and evening temperature, and their morning and evening pulse. Then for twelve weeks I gave them opium in the form of tincture opii of the 'British Pharmacopœia' in increasing doses, noting every week their mental state, their weight, temperature, and pulse. For the first two weeks I gave them twenty-

Table V.

Name.	Age.	Weight before taking opium.	Weight after taking opium.	Average morning temperature before medicine.	Average evening temperature before medicine.	Average morning temperature after medicine.	Average evening temperature after medicine.	Average morning pulse before medicine.	Average evening pulse before medicine.	Average morning pulse while taking medicine.	Average evening pulse while taking medicine.	Patients' mental state.
		lbs.	lbs.									
J. G. . .	61	133	123	97°	98°	97·8°	97·6°	77	89	93	71	Chronic mania; 4 years' duration; excitement severe; no remissions; intelligence not quite gone.
E. M. . .	42	128	122	98·2°	97·7°	97·2°	97·6°	78	93	81	77	Chronic mania; 4 years' duration; exacerbations, but not regular; mental powers very much impaired.
M. T. . .	34	148	140	98·6°	97·8°	98·5°	97·4°	74	74	82	73	Chronic mania; 10 years; regular periodic exacerbations; great excitement; mental powers not so much impaired as any of the others.
J. H. . .	26	134	127	97·8°	97·5°	97·5°	97·2°	100	77	91	74	Chronic mania; 10 years; mind much impaired.
C. M. . .	30	113	114	98·4°	97°	97·5°	97·5°	104	93	90	79	Chronic mania; 3 years; tendency to phthisis; great impairment of mental powers.
S. R. . .	35	116	103	96·9°	97·7°	96·6°	97·4°	81	78	80	71	Chronic mania; 4 years; great excitement and violence; mental powers considerably impaired.
E. S. . .	39	105	103	98·4°	97·7°	97·5°	97·6°	103	94	93	89	Chronic mania; 10 years; one lung tubercular; mind quite impaired.
Aggregate weights and average temperature and pulse		877	832	97·9°	97·6°	97·5°	97·5°	88	85	87	76	

five minims three times a day, for the next two weeks one fluid drachm three times a day, for the next eight weeks one fluid drachm and a half three times a day.[1] Of course the patients during all this time were in the same circumstances with regard to diet, clothing, and other conditions. The reason I kept up the drachm and a half doses so long was, that this is about the limit of the doses commonly used in mania, and I wished to ascertain the effects of such ordinarily employed doses. At the end of the twelve weeks the medicine was stopped. Of the nine I found that the opium caused such persistent sickness and total absence of appetite in two, that I could not continue it for more than a few days. There were only seven, therefore, in whom the experiment was continued to the end.

Excitement.—As regards the maniacal excitement, I found that in none of the cases did the twenty-five minim doses subdue it in any degree, and during the fortnight they took this dose there was on perceptible change in their appetites, weights, temperatures, or pulses.

During the fortnight they took drachm doses there was a very perceptible difference in the maniacal excitement in all of them but one, who at the time was passing through one of the regular exacerbations which characterised her case. In three of them there was a decided tendency to drowsiness through the day. In one case the partial subsidence of the excitement which characterised the first week did not last through the second, for by the end of it she was about as excited as ever. Five of them had begun to lose in weight, though the absolute loss was small, being only eleven pounds in the five. There was a slight fall in the temperatures of most of them.

When the dose was raised to a drachm and a half the excitement was very markedly lessened or altogether overcome in all of them. This effect was not lasting, however, in all the cases, for by the end of six weeks two of them were nearly as excited as ever, and the one who was subject to exacerbations had one of these during this period, and was almost as bad as when she was free from the influence of any drug. The most careful examination into the character of the cases did not show any reasons why one case should have been more and longer affected by the opium than another. To refer to Table V, J. G. and C. M. became almost as bad as ever when taking the medicine, and M. T., during one of the exacerbations of her malady, was but little affected by it. One of these patients was old, the other two young. In one case the mental powers were very much affected, in the other two not so much so. Two of them were robust, the third had a tendency to phthisis.

The results ofthe treatment in all of them are shown in Table V.

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[1] They got the first dose of the opium at seven o'clock in the morning, and the temperatures were taken at half-past ten. I wished to avoid the immediate effects of a dose of the drug.

Weight.—They all lost weight while taking the large doses of the drug. In some of them the loss was considerable, in others trifling. The greatest loss was thirteen pounds, the smallest one pound. The aggregate loss in all the cases was forty-five pounds. The patients whose excitement was most subdued did not lose most, nor did they lose least. It may be thought that the total amount lost in weight by them all is very small indeed, but it must be remembered that all those patients had no doubt lost greatly in weight when they first became excited, and were mostly at the minimum consistent with such health as they enjoyed. The opposing tendencies of the excitement of the brain and the reparative powers of the food they ate had found their balance, as it were, in each of them, and the effect of the opium was to give some more strength than had previously existed to the exhaustive forces.

Temperature,—On comparing the average temperature of each of those patients when taking no medicine, and during the whole time they were taking the opium, we find (Table V) that in every one of them but one it was lower while taking the medicine. The actual fall in each case is seen to vary from 1° to ·1° in the morning temperature, and from ·5° to ·1 in the evening temperature. The total amount of the loss of temperature in the seven was in the morning 2·7°, and in the evening 1·1°. This seems small and unimportant, but it must be remembered how much the permanent lowering of one degree of temperature represents of loss in vital energy and reparative action if it is already below the normal amount, and how much of good it may represent if it is above the natural standard.

The average temperature of those patients was higher than most other classes of patients in the asylum, and higher than the average temperature of forty sane persons who were employés in the asylum, which I found to be 97·5° in the morning, and 96·7° at night. Was it not, therefore, a health tendency, this reduction of the temperature caused by the drug? To answer this we must take into account certain facts in regard to the temperature of the insane. I found from an examination of the temperature of patients labouring under all forms of insanity, that a high evening temperature, as compared with the morning temperature, represents a large mortality in the class where this exists. Any drug that would have a curative tendency must reduce the evening temperature. In the cases experimented on, it is seen that the reduction of the evening temperature is very slight as compared with the morning temperature of the patients, and that, therefore, the average evening temperature is relatively higher while they were taking the opium than when they were not, the difference between the average morning and evening temperature of the same persons was ·8°, the difference in those seven patients taking no medicine was ·3°, while the difference after they began to take the opium was nil. It seems to me, there-

fore, that taking the effects of the opium on the weight and temperature of the patients together, we must conclude that it lowered the reparative power of the body below the point at which it could, as it were, cope with the destructive tendencies of the brain excitement.

It will be clearly observed that my experiments, though pointing to ill effects that may result from the use of opium in maniacal excitement for short periods or in single doses, yet tend to show that those ill effects will probably only be slight at first. The necessity or the supposed advantage of temporarily subduing the excitement may be so great or so urgent in any particular case that the physician will decide to do so by opium, notwithstanding those risks.

Pulse.—The average frequency of the morning pulse with opium and without it does not show any constant result in all the cases. But if we look at the evening pulse we see that in every case it was lower after taking the opium than before. The pulse of a chronic maniac is a most variable quantity, especially during the day, when there is much movement of the body, and the indications got from it are not much to be relied on. Taking all the cases there was a lowering of one beat in the general average of the morning pulse, and of nine beats in the evening pulse, the numbers being 88, 87, and 85, 76.

It will be observed that all those effects were the result of a continuous use of the opium in doses that were far from being narcotic in their effects. In no case did any comatose symptoms show themselves. Sickness was not caused in those patients who continued to take the medicine. In those whose excitement was allayed there was no torpor of mind or body produced so that they could not take their food or take their usual exercise. In regard to sleep there is no doubt they all slept very much better when taking the opium than before. The functions of the hemispheres of the brain were disordered, and this in all cases tends to impair or interfere with the healthy nutrition of the body, and opium when given continuously in the doses in which I gave it, whether as in some of the cases it seemed to allay the symptoms of the disordered cerebrum, or whether it did not do this, yet in all cases it still further interfered with the proper nutrition of the body, and pushed it one step further down hill in the direction of death.

The rise in temperature, which was the immediate effect of single doses of opium, was thus seen not to last when the drug was given continuously. The loss in weight among the patients is, no doubt, directly connected with the tendency observed in the experiments with single doses to interfere with the appetite for food. The element of uncertainty in regard to its effect on different cases was seen to exist when it was given continuously just as much as when single doses were given, and an explanation of this was as difficult in the one case as in the other.

In order to compare accurately the effects of a continuous course of a mixture of the bromide of potassium and cannabis Indica with that of opium, I discontinued the use of the latter in the cases of those seven patients, and waited till the same time of year came round as that in which I had made the preceding observations. I then, after having observed their mental state and weighing them, put them on half-drachm doses of each thrice a day, and continued this for a fortnight, but finding that the medicine was having an effect, and showing no signs of losing that effect, I continued its use for a fortnight longer. I then increased the doses to forty-five grains of the bromide and forty-five minims of the tincture of cannabis, and continued this for a fortnight, but as this was having a very decided and continuous sedative effect I could not safely increase the doses any more, except in one or two of the cases, to whom I gave a few doses of a drachm of each, and in whom the effects were decidedly too strongly narcotic to be long continued. I then reduced the doses to a half drachm of each. I found this treatment so beneficial to the patients that I have continued it now for about eight months, with a few days' intermission occasionally in all the patients. In the case of those whose excitement was periodic I gave it during the excited periods only. I have noted some of the results that could be tabulated in Table VI. They are shortly these :—

Excitement.—The half-drachm doses had the effect of allaying the

TABLE VI.

Name.	Weight.				Morning Temperature.		Evening Temperature.		Morning Pulse.		Evening Pulse.	
	Before taking medicine.	After four weeks.	After six weeks.	After eight months.	Before taking medicine.	After six weeks.	Before taking medicine.	After six weeks.	Before taking medicine.	After six weeks.	Before taking medicine.	After six weeks.
	lbs.	lbs.	lbs.	lbs.								
J. G. . .	128	125	130	123	97°	96·1°	98°	97°	77	87	89	60
E. M. . .	130	128¼	131	134	98·2°	96·5°	97·7°	96·7°	78	86	93	82
M. T. . .	134	139	138	135½	98·6°	98·7°	97·8°	98·2°	74	83	74	68
J. H. . .	126	122	122	124	97·8°	97·2°	97·5°	97·4°	100	110	77	80
C. M. . .	109	107½	105	110	98·4°	98°	97°	97·5°	104	83	93	81
S. R. . .	106	106¼	107	108	96·9°	97·3°	97·7°	96·9°	81	77	78	67
E. S. . .	102	103¾	101	106	98·4°	98·2°	97°	98·4°	103	98	94	96
Aggregate weights and average temperature and pulse	835	831¾	834	840½	97·9°	97·4°	97·6°	97·4°	88	89	85	76

excitement in all the cases but two. This was quite as strongly marked as the first effect of the drachm-doses of laudanum, and during the nine months it has been given there seems to be no per-

ceptible tendency to lose its effect. This is in most marked contrast to the manner in which the sedative effect of the opium was lessened or lost in a week or two. The effect of each dose is not so soon observed, but lasts longer than each dose of the opium, and is not so apt to cause an approach to narcotic drowsiness in any case. The patients look better, less as if they were under the influence of a narcotic drug, and more as if their maniacal excitement was naturally abated. The forty-five grain and forty-five minim doses were in one of the patients followed by a decided drowsiness and sluggishness, with coldness and paleness of the skin and weak pulse, and this was also the case to a greater extent with the drachm doses. But when the excitement was very intense indeed, even these doses were not followed by any such effects.

Weight.—For the first four weeks, and with the half-drachm doses, the aggregate weight of the patients diminished about four pounds, four having lost in weight and three having gained. It will be remembered that during the same period under the opium treatment they lost eleven pounds. Curiously enough nearly all the patients who lost under the opium gained weight under the other treatment. At the end of seven weeks the patients were beginning to gain in weight, so their aggregate weight was only one pound less than when they began the treatment, and now at the end of eight months their aggregate weight is five and a half pounds more than it was to begin with, five having increased, two diminished in weight, and one remained stationary.

Appetite, &c.—In no case was the appetite interfered with. At very rare intervals the mixture produced sickness in one of the patients. Their tongues all remain clean, and no constipating or purging effect on the bowels has been produced.

Temperature.—As seen in Table VI, the average morning temperature of the patients fell ·5°, and the average evening temperature ·2°. The latter result I consider as more favorable than the results of the opium treatment. Taking each patient separately, five of them fell in morning temperature, and four of them in evening temperature. There was no fall in the evening temperature relatively to the morning temperature, in this respect not being different from the opium.

Pulse.—The pulse was slightly increased in frequency in the morning and diminished in frequency at night (see Table VI), the diminution not being nearly as great as that caused by opium. In three of the cases the pulse was slightly weakened.

If we compare the general results of those two modes of treatment it is seen that the maximum of good effects and the minimum of those that are ill in their tendency were obtained by the use of the combination of half-drachm doses of bromide of potassium with thirty minim doses of the tincture of cannabis Indica.

It is interesting to compare the results of the two modes of

treatment I have described with the effects of bromide of potassium alone in large doses on the weight and pulse and temperature.[1] I had been giving it to twenty epileptic patients for thirty-eight weeks in doses rising from five grains three times a day up to fifty grains three times a day, with the following results. They gained steadily in weight for twenty-eight weeks, and their aggregate weight was then fifty-six pounds more than when they began to take the medicine. During the last ten weeks, when they were all taking 150 grains of the medicine per diem, they lost forty pounds. At the end of the time they were still sixteen pounds heavier in the aggregate than they had been to begin with. During the same time the effect of the medicine on their temperature was to lower it steadily until forty grain doses were reached. After that it rose, until at the end of the ten weeks of fifty grain doses it was above what it had been to begin with. Still the difference between the morning and evening temperature was greater at the end of the time than it had been to begin with. The effect on the pulse was to lower its average frequency steadily up to forty grain doses, and then to raise it slightly, but at the end of the time its average frequency was not so great as it had been to begin with. The patients who took the bromide of potassium being epileptics, the effects of the medicines above described cannot be compared with it with perfect precision, but still the general result holds good, that the tendency of the bromide of potassium was at least up to 120 grains per diem, in the direction of health, while from the beginning the effects of the opium were as regards the bodily state in a direction away from health, and the addition of the cannabis Indica to the bromide in the maniacal patients, while it had a good effect on the maniacal excitement, did not seem materially to interfere with the nutritive process.

It has been the result of my experience with bromide of potassium given either in epilepsy or in insanity, given alone or in combination with cannabis Indica, that there is a certain dose which may be given with perfect impunity as regards the general health, and with great benefit to the disease for long periods, and that if this dose is increased cumulative effects will show themselves, and all the symptoms of poisoning will come on. The safe and beneficial dose differs in different cases. It would seem as though the kidneys (through which the salt is principally eliminated from the system) can only carry away a certain amount in each individual. I have given twenty-five grain doses three times a day to seventeen epileptics for two years, with a break of only one week, and in only two cases did any constitutional symptoms show themselves, and that was not till the end of a year. The others are all much the better for the medicine, having gained in weight, and improved in general health.

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[1] 'Journal of Mental Science,' Oct., 1868.

And when I put twenty-nine epileptics on the medicine in graduated doses, beginning with 15 grains per diem and ending with 150, only the twenty I have referred to stood this treatment for the thirty-eight weeks it was persevered in. At the end of eleven weeks, when they were all taking 75 grains per diem, a boy of fifteen showed signs of being "bromidized;" two men, at the end of seventeen weeks, when taking 105 grains, began to feel bad effects, and two others, at the end of eighteen weeks, with the same doses as the last, showed that the medicine was accumulating in the system. The same phenomenon we shall observe in the clinical observations which follow where the bromide was combined with Indian hemp. In some cases, drachm doses of each were given three times a day for weeks with good effects; in other cases, the same doses could not be continued for more than a few days. This I regard as one of the most important facts yet discovered in regard to the bromides. I have as yet been able to discover no fact by which we can predict beforehand that any particular case will stand large doses for a long period, or that another case will not do so with impunity. Until such a test is discovered we can only give them tentatively in gradually increasing doses in each case until we get up to the maximum of good result without any danger of the cumulative effects of the drug. My experience has been that a strong, vigorous patient, with all the functions of the body performed actively, will generally stand large doses for a longer time than a weaker patient: but to this I have seen exceptions. The salt being eliminated by the kidneys would point to giving a diuretic along with it in cases where it is considered of importance to give large doses, and yet not cause cumulative effects. Indian hemp has been much used as a diuretic. I have given some Spt. Eth. Nitrosi with each dose in such cases, but my experience on this point as yet has not been sufficient to enable me to express any conclusion as to the result.

To test the effects of bromide of potassium alone on acute maniacal excitement, I selected by far the most violent case of periodic mania in the asylum, a woman in whom the attacks of excitement had come on about every month or six weeks for two years, and lasted from a fortnight up to a month. She was a young strong woman in good bodily health. I had tried opium in this case, but it aggravated all the symptoms, and tincture of hyoscyamus in half-ounce doses thrice a day produced but slight abatement of the symptoms. On the occasion on which I made the experiment she became suddenly excited, on the 13th of March. On the 14th she was furiously maniacal, shouting, restless, sleepless, most violent and destructive, with a strong pulse of 90, flushed face, suffused eyes, muscular system in constant activity, and temperature 99·6°. I put her on two-drachm doses every three hours, on this the second day of her excitement. In forty-eight hours, after she had taken four ounces,

she was as excited as ever, but her tongue was beginning to get furred in the centre with a raw line down each side, and there seemed slight muscular unsteadiness. Her pulse too was somewhat weaker. The medicine was given for another day and a half, until she had got seven ounces of it. The maniacal excitement then quite suddenly abated, and her mental state became one of torpid depression. She became pale and pinched-looking, the pupils sluggish, the pulse 108 and very weak, and the temperature fell to 96°. These symptoms increased after the medicine was discontinued, until the co-ordinating power of the muscles was so completely lost that she reeled like a most intoxicated man when she attempted to walk. She slept, almost continuously, for three days. She only took food when given to her, and seemed not to care for it. Her bowels were regular. Her tongue was at first furred with a thick white fur, and then got quite raw-looking. Her breath smelt of bromide of potassium. Her articulation was much affected. She remained in this state for about five days, her temperature remaining at 96°, and it was quite a fortnight from the time it was discontinued before she got over the effects of the drug. As she got better there was slight feverishness with dry tongue and want of appetite. The excitement did not return when the effects of the drug passed off; but the next attack began on the 10th of April, which was sooner than it ought to have come on by a week at least.

This experiment is instructive, as showing, 1st, that the most acute excitement can be subdued by bromide of potassium; 2nd, that this cannot be done without pushing the medicine far beyond what is safe; indeed, almost up to complete paralysis of the cerebrum and sympathetic ganglia of the heart; 3rd, that the action of the drug in such a case is strongly cumulative, increasing in intensity for days after it has been stopped, and lasting for a long time; and 4th, that no permanent improvement is necessarily produced in the morbid cerebral action. I do not regard this a case of cutting short the excitement. It was rather one of half-poisoning the patient. If any justification of such an experiment is needed, I must plead the importance of knowing exactly the effects of the bromide on maniacal excitement, the hope that benefit might possibly accrue to the patient, and the absolute want of any precedent to guide me. It seems to me highly instructive, clinically as well as physiologically. Such a case should show the necessity for stopping the bromide at once when its bad effects are first observed, on account of this cumulative action. It illustrates the prolongation of the effects of this as compared with any other drug that has the power of producing the same narcotic or paralytic action on the nervous system. It proves that maniacal excitement gives the same tolerance to the system in resisting the ordinary physiological effects of this drug as in the case of the ordinary vegetable narcotics.

Clinical Observations.—The preceding observations and experiments having been undertaken chiefly with the view of obtaining more accuracy as to the immediate and remote effects of bromide of potassium and its combinations, as compared with opium, on maniacal excitement, and on the general health of patients labouring under excitement, I shall now record my experience of the effects of the salt and its combinations when given in the ordinary course of my medical practice among the insane. I began to give the bromide in a tentative manner in the end of 1867, and have continued to use it ever since. It had at that time been recommended for various forms of insanity in several of the home and foreign medical journals. My attention was first strongly directed to the powers of the salt in brain disorder by a case which I was treating in the beginning of 1868. I had amongst other things been giving both bromide of potassium and tincture of cannabis Indica to procure sleep in this case, which was one of melancholia, with great excitement and hallucinations, and by way of experiment I gave the patient a combination of the two. I found the effects to be so very wonderful in this case that I employed the bromide alone, and in conjunction with Indian hemp very largely thereafter in similar cases. I need scarcely say (the subject being therapeutics) that my first impression, that I had discovered a panacea for some forms of brain disorder, was disappointed, but I have found very good results from this combination in very many patients, and I shall proceed to give a summary and an analysis of my cases.

I have given bromide of potassium alone or along with Indian hemp in fifty-one cases of various kinds of insanity. I mean that in those cases I have given it a fair trial to relieve or cure the disordered brain function. I have used it in a more desultory way in many more cases, but of course such a mode of giving a drug is quite useless for any scientific purposes. As regards the forms of insanity to which my cases belonged I have put them in a tabular form (see Table VII). And in the same table I have distinguished between the cases in which its use seemed to be attended with benefit, and those in which this could not be said to be the case. The first important fact in regard to this table is (and it may be thought to be a suspicious one), that those forms of insanity which are well known to be most curable figure most largely among the benefited. Of course this might have been expected, but I exercised what care I could in each case, so that the effects of the drug might be distinguished from the improvement that must have occurred in many of those cases in the ordinary course of the disease. When a remedy is said to be very beneficial in such curable affections as acute mania, puerperal mania, and insanity occurring at the change of life in women, we must carefully test its real efficacy, if it is not to fall into the disrepute of those panaceas for measles, jaundice, and delirium tremens which our

fathers so strongly believed in. The table as it stands was the result of my first analysis of the cases, and I believe it to be so far correct, but in Table VIII I think I have excluded all possibly doubtful cases,

TABLE VII.

Form of insanity.	Seemed to do good.			Seemed to do no good.		
	M.	F.	Total.	M.	F.	Total.
Acute mania	6	1	7	...	2	2
Chronic mania . . .	1	...	1	...	4	4
Periodic mania . . .	4	8	12	1	...	1
Puerperal mania . . .	...	9	9	...	1	1
Melancholia	1	2	3	...	2	2
Insanity at change of life .	...	4	4	...	...	...
General paralysis . . .	2	3	5	...	...	...
Total	14	27	41	1	9	10

and only claimed credit for the remedy where I had an opportunity of applying some crucial test, such as stopping the medicine, watching the progress of the disease without any medicine, and then giving it

TABLE VIII.

Form of insanity.	M.	F.	Total.
Acute mania	3	...	3
Periodic mania . . .	...	4	4
Puerperal mania . . .	...	2	2
Melancholia	...	1	1
Insanity at change of life .	...	2	2
General paralysis . . .	...	1	1
Total . . .	3	10	13

again. I think that not even the veriest medical sceptic in this sceptical time would take exception to any of these thirteen cases. I shall presently quote some of the most typical of them. They were many of them obstinate examples of their respective forms of insanity, which had "defied other modes of treatment." If to a patient whom one has known to have had regular attacks of periodic mania for years, we give a medicine at the commencement of an attack, and the patient's

excitement ceases, contrary to anything known in the history of the case before, then I think we may fairly conclude that the medicine and the absence of mania are cause and effect. If in a case of mild melancholia at the change of life in a woman, the disorder has existed for a year and a half, if most of the remedies ever before recommended for that class of cases had been tried and had failed to do good, and if at last the bromide of potassium procures sound sleep, and immediate visible improvement in appetite, weight, and mental state, surely some credit may be given to it. But if in this same woman its use is intermitted, and all the symptoms at once return, and again immediate improvement follows its employment, so that the patient becomes able to employ herself as she never did before since her illness, and through healthy employment gains in flesh and strength, and gets quite as well in three months as ever she was in her life, surely we cannot deny to therapeutics a cure in the best sense of the term. Or if a cure cannot be expected, as in a case of general paralysis, if a mixture of bromide of potassium and Indian hemp so subdues intense excitement, that when not taking this medicine the patient is noisy, violent, destructive, sleepless, and rapidly losing weight, and when taking it he is quiet, semi-rational, dresses and eats properly, and remains in this state for six weeks, till the disease in its natural course passes into its quiet stage, I think here we have a palliative of great value and importance. Or if an old lady gets irrational, restless, sleepless, and unmanageable by her relatives, and if apparently the last alternative to sending her to an asylum has been tried and failed, until half-drachm doses of bromide of potassium and tincture of Indian hemp is found to subdue and quiet this irritability and restlessness, so that she can be quite well kept at home, for the month or two during which this excitement lasts, and until the ordinary dotage of old age to which this excitement was a prelude, comes on, surely the physician's power was augmented, and the patient was unquestionably the better for the remedy he employed.

In acute mania I seldom found the bromide given alone do any good, or, indeed, have any perceptible effect. I gave it in all doses up to 120 grains three times a day, and I continued its use in some cases for a few days. But when combined with tincture of cannabis Indica the effects of the mixture were in many cases very remarkable. Sometimes if the excitement was very intense I began with drachm doses of each three times a day, or, in some cases, every three hours for the first day. In the cases in which the effects were good, they usually appeared by the end of the first day of its use. The patients became less restless, the shouting and violence were abated, and at night they slept. The skin, too, which is so often dry in acutely excited patients became more moist, and they perspired freely. The pulse usually lost in force. Indeed, this is the only

objection I have to this mixture, that the force of the heart's action is undoubtedly lessened in most cases by it. But I have never seen a single case of syncope, except in one woman who fainted two hours after a dose, but soon recovered. The lessened force of the heart was shown, too, by the paleness of the face and skin generally. After the medicine has calmed the excitement the patient remains confused in mind. The intelligence and coherence of ideas, of course, do not usually return for some time. It is often sufficient if one or two doses per diem are given after the first day or two, and I have stopped its use altogether at that time—the patient remaining free from acute excitement. The greatest advantage of this sedative over every other that I have tried in acute mania was, that these patients took their food as well or better during its use as without it. Every one who has acute mania to treat knows that there are three great risks. The patient's appetite may fail, the excitement may cause complete exhaustion or death, or it may last so long that the power of the brain to become the medium of normal mental manifestations seems to be lost or impaired, and dementia results. There can be no doubt that the patients being got to take a large amount of nourishing food and stimulants is of the very first importance in all cases of acute mania, and it is the great risk of taking away the patient's appetite that prevents opium or henbane being more extensively used. Especially is this risk great if we give large doses of opium. It seems to me that the bromide and Indian hemp combined approached more nearly by far than any other drug to our great desideratum in treating acute excitement of the brain, viz. a medicine that will so alter or modify the morbid functions of the brain, that the patient will cease to exhaust all his bodily energy in muscular movement and constant wakefulness, and will at the same time allow the reparative effects of rest and food to act quickly in restoring the normal nutrition of the cerebrum. In some cases complete recovery of the mental powers took place very soon indeed after the excitement was subdued; in others, the confused and incoherent state remained for a long time. In the three cases I have put down in Table VIII the patients were rational or coherent or nearly so within a fortnight after getting the medicine, though one was of a month's duration; the excitement in each case being of about three days' duration after being put on the mixture. The cases in which the good effects are less marked are those in which the excitement is subdued, but the patients remain confused in mind, incoherent and suspicious, sometimes with delusions for periods varying from one to six months. The cases in which its use is followed by no particular benefit as regards cure are those (and in my experience they were rather the exceptions), in which it fails to allay the excitement except when given in very large and continued doses; and when after its use has been continued for a week or two

the excitement still remains as acute as ever if the medicine is stopped. If good effects are not manifested within a fortnight of treatment in a curable case of acute mania, my own opinion is that then the case should be left for a time at least to nature, with appetizing tonics and nourishment alone. In all the cases of acute mania where I say that the medicine did good, I mean that its effects were distinctly in the direction of health, and not merely that the symptoms were relieved. In some of those cases in which the best effects resulted from the use of the drug, I think that if it had been given at first the patients need never have been sent to an asylum at all. If my anticipations in regard to it are realised, this will unquestionably be one of the most important effects of the remedy. To be able to treat many cases of insanity, especially if attended with excitement, at home has been impossible just because we had no remedy that could safely be given to allay the excitement without the risk of interfering with the recovery of the patient. In the case of senile mania to which I referred, the patient was treated quite well at home. Some cases of maniacal excitement of short duration which now have to be sent to asylums will, I think, be saved from this by the use of the bromide and Indian hemp combined. There are few risks attending its use, and its good effects, if there are to be good effects, are so very soon seen and follow its use so manifestly, that there generally can be but little question of mere coincidence.

In these forms of maniacal excitement which have hitherto been found to be incurable, the bromide of potassium and its combinations are no more powerful than other drugs have been found to be in effecting cures. But in many of those cases its effect is to modify the symptoms of the disease so much that the lives of the patients become far more tolerable to themselves and others. In chronic and periodic mania, I have given the bromide combined with Indian hemp in eighteen cases, and it produced good effects in thirteen of these. In four cases of periodic mania to whom I gave it, the effects were, perhaps, more wonderful than in any others, because the patients had all confirmed excitement of a severe character; the history of their previous attacks was known, and could be contrasted with their attacks when getting the drug. In three cases the effect of the drug was to cut short an attack when it was coming on in its ordinary course as it had come on before. In two of the latter the attack was only postponed, as it were, but in the third case the patient remained well, was discharged from the asylum, and has kept well for twelve months—a far longer period than she has ever been free from excitement before for five years. I shall relate the case more fully afterwards. The other two were not so striking, but still are curious. One was a woman who had in her youth taken epileptic fits. After these ceased she became subject to severe attacks of excitement, which came on about every two months, and

lasted for a fortnight. At the beginning of one of these attacks I gave half-drachm doses of bromide of potassium three times a day, and the excitement ceased within twenty-four hours. The patient continued to take the medicine for two months and got better mentally than she had been for several years. It was discontinued to see if the effect was permanent, but an attack of excitement came on at once, and the medicine, though it has since controlled and modified such attacks, yet has never quite stopped them. Another case was that of a woman who for a long time had had an attack of acute excitement every three or four years, the attack usually lasting from six months to a year. She became suddenly maniacal, and got at first drachm doses of bromide thrice a day without any good effect, then half-drachm doses combined with half-drachm doses of tincture of cannabis, but still the excitement was daily getting more intense till she was incoherent, noisy, sleepless, dirty in her habits and violent. The quantity was increased after a few days to forty-five grains of the one and forty-five minims of the other every three hours, with the effect of completely allaying excitement, so that in two days she was removed back to the convalescent ward, remained rational, industrious, and apparently well in mind for a week, during which time she got no medicine. At the end of that time the excitement began again, and is now running its usual course; its symptoms, however, being wonderfully controlled by forty-five grain doses of the bromide with forty-five minims of tincture of cannabis twice or three times a day. She has taken this for three months, and though far from coherent or rational, yet sleeps, and is not destructive or dirty or violent, as she used to be and is now, when the medicine is stopped. She has lost in weight very much, but takes her food well. The comparative loss in weight as compared with former attacks I am not able to say, as she was not weighed in the different stages of former attacks.

Another case is that of an old woman who has taken periodic attacks of mania for at least twenty years, and has been so much better during her last attack under the use of drachm doses of the bromide and tincture of cannabis morning and evening, that she has been kept in the infirmary ward of the asylum during the nine months the attack has lasted, and has during that time slept in a dormitory with other patients, has taken her food, and is now passing into the quiet stage of her disorder. In every attack which had occurred before, she had been destructive, dirty, very noisy, and had to be all the time in the refractory ward.

In one or two cases of very severe excitement the attempt to suppress it by often repeated doses of the medicine has seemed to do harm. The patients got into a state resembling acute dementia, and their nutrition was much interfered with. In one case to which I referred, where the person was old, very weak, and the pulse very

thready, she once fainted after getting a drachm dose of each, but she very soon revived.

The forms of insanity in which the bromide or its combination with Indian hemp did most good were puerperal mania, and that form of mild insanity which occurs at the change of life in women. I used it in ten cases of puerperal mania, and in four of such climacteric insanity (see Table VII), and in all except one its use was attended with benefit. In two cases of puerperal mania, both very violently excited, the employment of forty-five grains of the bromide with forty-five minims of tincture of cannabis three times a day was followed almost at once by alleviation of the excitement, and in about a month by recovery. In another case of puerperal mania of three days' duration, and of the most violent character, I gave drachm doses of each every three hours, with the view of cutting short the excitement at once, and in two days the excitement was quite subdued, but the patient remained stupid and vacuous in mind for a fortnight (taking her food quite well, however, during that time), and though now, after three months, quite coherent, industrious, and rational on most subjects, yet is suspicious, and has some delusions. I do not think I should again give the medicine in such a case in quite such quantity, but rather endeavour to allay the excitement a little more gradually. I am quite sure, however, that to have subdued the excitement in that way with any other drug I know would have been followed by total absence of appetite, dry tongue, and much feverishness.

In five of the cases where the excitement was milder, and where the chief characteristics of the disorder were sleeplessness, restlessness, delusions about husband and children, reduced bodily condition and impaired appetite, I found drachm doses of the bromide given every night procured sleep, and seemed also to increase the appetite, and allay the restlessness and unsettledness of mind, and the patients recovered sooner than my experience of similar cases would have led me to expect without the medicine.

In the cases of insanity at the change of life in women, I found that drachm doses of the bromide alone at night was most beneficial in procuring sleep and allaying the restless depression that usually accompanies this form of aberration. In one of these I had tried opium most carefully, and it had failed to do any good, while the use of the bromide was at once followed by much benefit, and its continued use by complete recovery in two months.

I have given the bromide of potassium alone and in combination with the Indian hemp in five cases of melancholia, and with slight benefit in three of them, but with decided benefit in only one case, and that I shall afterwards relate. In ordinary melancholia the bromide does not do much good, except by procuring sleep, and combined with cannabis it often seems to do harm. If there is much

restless excitement, with hallucinations of hearing, they may do good, not otherwise.

The last form of insanity in which I have used the mixture of bromide and cannabis is general paralysis, and of course in that most fatal of diseases I merely expected, and only got, palliative results. But in no disease is a good palliative of the symptoms in the worst cases of more real value, especially in an asylum, and after my extensive trials of opium (the worst of all in this disease), henbane, digitalis, Indian hemp alone, and bromide of potassium alone, I have found the mixture of the two latter, given in doses of from half a drachm to a drachm of bromide with a drachm to a drachm and a half of the former, to be the safest, surest, and most manageable in its effects. All physicians who have had experience in the wards of an asylum know that of all cases of insanity a general paralytic in the first or beginning of the second stage of the disease passing through the period of excitement which often occurs then, is by far the most difficult to manage. In most other forms of maniacal excitement is there some faint approach to self-control or amenability to control by others, but in this the noise, the violence, the destructiveness, the entire absence of any sort of fear of consequences in annoying fellow-patients, the sleeplessness and restlessness, are simply unmitigated and incessant. An ordinary maniacal patient may generally be taken by an attendant and walked about in the open air, but an excited general paralytic fights and struggles until he or his attendant gets injured in some way. It can be imagined what a boon for such a case, for his attendants and for his fellow-patients, it would be to have some sedative medicine which would somewhat allay his violence and yet not interfere with his appetite until the period of excitement was tided over. Such cases are notoriously intolerant of opium; henbane has been hitherto most relied on in half-ounce and ounce doses of the tincture, but if long continued it causes dryness of the mouth and lips, and loss of appetite; digitalis has been strongly recommended, and in some cases its effects are admirable, but there is a wide-spread mistrust among those who have used it much that it is not a safe drug to give in all cases—one patient poisoned, or nearly so, by it, causes an excusable timidity in using it in most minds, and it is surprising how many asylum physicians have this timidity.

I have given the bromide and Indian hemp to five cases of general paralysis in the most excited and worst stage of the disease, and in all of them I found the worst and most troublesome features of the excitement abated, without causing much loss of appetite. In one case of most violent excitement I was giving ninety-grain doses of the bromide with ninety minims of the tincture of Indian hemp for weeks, and the patient's tongue got thickly coated, the appetite was impaired, he became very sleepy, and all the other features of "bromidism" showed themselves. But this I attribute entirely to the

large doses of the bromide so long continued. I do not think that the doses of this should exceed a drachm, or even forty-five grains if it has to be given three times a day and *long continued*. The great advantage of this mixture is that single doses will *never* do any harm, nor is there the least risk in going on with it for a few days; and that any bad effects come on gradually, and can be observed before any harm whatever is done to the patient. By lessening the doses of the bromide, the bad symptoms at once disappear. In one case of most violent general paralytic excitement I gave forty-five-grain doses of the bromide and forty-five minims of the cannabis morning and evening for many weeks, the patient during that time working out on the farm, sleeping at night, and behaving rationally, while if it was stopped for two days he got noisy, dirty, violent, unable to do any useful work, and quite maniacal. He quietly passed into the second stage of the disease, when the medicine was no longer required. In general paralysis in women it is most useful in half-drachm doses of each. If used in the end of the second or third stages of general paralysis it subdues excitement in small doses, but it increases the want of co-ordinating power of the muscles. Especially is this seen in the patient's walk. I have seen a drachm dose of each quite take away the power of walking for a day in a general paralytic who had previously been rather shaky on his legs. It does not in any way affect the peculiar delusions of general paralytics. When a patient is beginning to be excited, he should get one drachm of each at bedtime, and then half-drachm doses should be tried every three hours next day, or until the excitement is in some degree subdued. It will then be sufficient to give one dose in the morning and another at night in many cases, or at most three times a day. If the tongue gets much furred after using the medicine long it will be quite sufficient to stop its use for a few days.

I shall now give an abridged account of a few of the cases in which I employed either the bromide of potassium alone or along with Indian hemp.

Acute mania.—W. B—, æt. 18, a boy who had been insane for three months, but whose symptoms had become gradually worse until he had become quite maniacal.

On admission he was a small, ill-developed youth. He was quite incoherent, restless, violent, and destructive. No bodily disease. Temperature, 95°. Pulse, 80. Conjunctivæ suffused; right pupil more dilated than the left. Tongue slightly furred. He was quite sleepless. He was ordered half a drachm of bromide and of tincture of Indian hemp three times a day. The excitement was evidently lessened after each dose. He took his food well, and on the fourth day after admission the excitement became greatly more subdued, and his mental condition one of confusion of ideas and stupidity. The medicine was then stopped, and in a week he was

coherent and rational, and rapidly gained in weight. In two months he had a very mild subacute attack for a few days, but has since then (six months) kept quite well.

Acute mania.—J. P—, æt. 27, a man who had been insane for a week. The maniacal excitement had come on suddenly, and after it commenced he was sleepless, restless, incoherent, and most dangerous. He tried to cut his mother's throat, and tore out all the windows out of a gentleman's dining-room. Maternal grandfather insane.

When admitted was in mechanical restraint (as he had been since attempting his mother's life), and was confused and suspicious looking, though partially coherent. He was a robust, healthy looking man, of 6 ft. 1 in., very strong, and his bodily functions all performed normally. He got worse mentally until in two months he was quite deliriously maniacal. He tried to choke everyone near him, sometimes making attempts on his own life, once very nearly killing both an attendant and himself. He was sleepless, his tongue got furred, and he had frequently to be secluded in a strong room for a day or two at a time. Hyoscyamus, opium, antimony, and stimulants were all tried in vain. He had the "ear of the insane" in October, and after that gradually got more quiet, till in the following January, a year from the time of his admission, he was rational, coherent, industrious, and quite free from excitement, though a little silly in mind. In the following September he suddenly took a violent fit of excitement when attending a concert one evening, and became as violent, dangerous, and incoherent as ever. He was at once put on drachm doses of the bromide with ninety-minim doses of tincture of cannabis, three times a day. In two days he was free from excitement to a great extent, and continued to get the medicine in half the above quantities. For the three months the excitement lasted he never required to be secluded, he worked on the farm regularly, he took his food, he exhibited none of the suddenly dangerous and violent paroxysms which characterised his former attack, though if the medicine was stopped he at once showed signs of being violent. The attack passed off, and he remains now free from excitement.

I think this case will have periodic attacks of excitement all his life, but after my experience of the power of bromide and Indian hemp to subdue the worst symptoms, I do not look forward to the coming on of the next attack with the anxiety and dread which I should have felt (and did feel when the second attack began) had I not known of this safe and powerful sedative.

Periodic mania.—H. S—, æt. 23. This young woman has had six attacks of mania in four years. She had been insane for four weeks previous to admission. All the attacks had begun during menstruation, and while maniacal she was always very erotic, especially at the beginning of the excitement. She was violent, inco-

herent, noisy, dirty in her habits, and sleepless before admission and for about three months afterwards. She then got well, but in six months had another similar attack of mania lasting for two months. She lost twenty-eight pounds in weight during this attack, and her temperature was always 1·5° above its normal rate when she was excited. She remained free from excitement for nine months, and then had another similar attack. After four months of sanity she one night suddenly got up, smashed the windows of her dormitory, saying that the devil was looking in, and became violently excited, her temperature that day being 100·8°, pulse 108 and strong. She was ordered drachm doses of the bromide every three hours with a drachm of ammoniated tincture of valerian with each dose. She was put into a dark room at her own suggestion. On the following day her temperature was 99·6°, and her pulse 108. She was still much excited, but not so much so as on the day before. On the second day her temperature was 99·3° and her pulse 130 and weak, the excitement being much allayed. The medicine was after this given only three times a day. She was kept in bed for a fortnight in a dark room, as she said that if she got up she would get worse. At the end of that time she was still rambling, partially incoherent, and full of delusions, but nearly free from active excitement, and the medicine was discontinued. She remained slightly affected in mind for another fortnight. At the end of a month from the day the excitement began, she was well, and was discharged from the asylum six months thereafter. I heard a few weeks ago that she was still keeping well, and it is now a year from the time her attack of mania was thus cut short (as it seems to me) by bromide of potassium. I gave the valerian because she was beginning to menstruate at the time the mania began.

It will be observed that the excitement in this attack only lasted about three days, and she had never been less than two months excited at a time in her nine previous attacks; the aberration of mind was only of a month's duration, it had never been less than between three and four months previously, every symptom of an ordinary attack being clearly present at first; and the interval of sanity has been even now longer than any such interval except that between the fifth and sixth attacks. The excitement disappeared as the patient showed signs of coming under the influence of the bromide and its constitutional symptoms were developed.

Periodic mania.—M. G—, æt. 56; a woman who has been rather weak-minded from birth, but got married and had children. She has been subject to attacks of excitement at intervals of a year or two for twenty years.

On her admission from another asylum, she was found to be a little thin woman, who went on talking quite incoherently, was rest-

less and destructive to her dress, and violent at times. Sometimes she refused her food, and had to be fed with the stomach pump. Though she got much food and stimulants she became quite run down, thin, and exhausted in mind and body before the attack was over. The first attack lasted from March till the following January; she had a short attack in April. In the beginning of the next year she had another short attack, and in the December following she had three epileptic fits (the first she ever had). They were the prelude to an attack of excitement which lasted for six months. In the following year she had another attack of excitement lasting for three months. In the beginning of this year she again became excited, and was put on drachm doses of bromide and tincture of Indian hemp, three times a day at first, and afterwards morning and evening. The medicine so completely moderated all the unpleasant symptoms of the excitement that she was kept in the infirmary ward among the sick patients. She was not noisy, destructive, and dirty in her habits as she had been before; she did not lose flesh to nearly the same extent as before, she took her food better than ever she had done before during excitement, and the attack terminated in September, leaving her far stronger than she had ever been before after a long attack of excitement.

This case illustrates the effect of the medicine on an old person very weak in body, and perhaps, therefore, more amenable to the effects of the drug. Such cases when violently excited in asylums, are far worse to manage, and cause far more anxiety than stronger patients, and, therefore, it is more important to have a mild and safe sedative.

Puerperal mania.—E. B—, æt. 33. This woman had been insane for four days, having been confined of her fifth child six weeks ago. She at first began to be suspicious and jealous of her husband, then became sleepless, restless, lost all interest in her children, and then got very violent.

On admission she was confused in mind, but soon became violently maniacal. Her temperature was 97·2°, pulse 92, strong; breasts full of milk. The usual measures were taken to stop the secretion of milk and relieve the breasts, and she was ordered a drachm of bromide of potassium and of tincture of cannabis every three hours during the day. By the end of a fortnight she was free from excitement, but was rambling in mind and full of queer constantly changing delusions. She ate and slept well most of the fortnight she was on the medicine. Her temperature fell to 96°. She has gone on improving, but rather slowly, and it was three months before the confused suspicious state of mind passed away. She often got, during that time, a drachm of the bromide at night for sleeplessness with the best effects. She now is almost well. Her recovery has been delayed by menorrhagia.

I am inclined to think I pushed the medicine too far in this case, and subdued the violent excitement too quickly. The prolonged after stage of confusion of mind, and the great fall in temperature, makes me think so; still the sedative effects were here most marked.

Melancholia with excitement and hallucination.—M. C—, æt. 60; a sempstress, unmarried, who had been insane for about three months. The immediate cause of her insanity is stated to have been a sudden shock which she received from a nephew shouting in her ear that he would kill her. She had "brain fever" twenty years ago, and is stated to have been rather "nervous" and irritable ever since. After the shock she got depressed in mind, and began to take fancies that people were going to hang her, that dogs were going to worry her on account of the crimes she imagined she had committed. She got so depressed in mind that she many times attempted to commit suicide by strangling herself. Had been sleepless. No hereditary predisposition to insanity.

On admission she was dull in mind, but quite coherent and rational on all points except that she said she was to be hanged. She was short and rather stout; tongue furred; pulse 96, very weak and thready; morning temperature 97·6°; evening temperature 97·2°; weight, 134½ lbs. Her pupils are both contracted and her eyes suffused.

For the first month she got no medicine. During that time her average morning temperature was 98·1°, and her evening temperature 97°, and the pulse was 100 and remained weak. She ate pretty well, and gained 3½ lbs. in weight in that time. She did not sleep well. Her delusions remained, and she got more depressed in mind. She was then put on one grain of opium three times a day. She slept better while taking this, but her depression of mind got worse. She had hallucinations of hearing, and after a fortnight the opium had to be given up. While taking it her temperature in the morning was 7° lower than it had been, and in the evening 1° higher, while her pulse was ten beats lower. She ceased to gain in weight after getting the opium. After this, various modes of treatment were adopted, and amongst others she got occasional doses of tincture of cannabis indica; but she continued to get worse and to lose in weight until, at April 1st, 1868, her state was the following:—"Is much excited, sleepless, restless by night and day, cannot employ herself in any way, imagines that she is to be hanged every minute, begs every one about her for a 'reprieve,' tries to get forcibly out of the ward door to get one; tries sometimes to commit suicide; says her brain is 'on fire,' and cries out, 'My head, my head—I'm confused. I don't know what I'm doing—I'm mad.' Has lost a stone in weight."

She still got worse, requiring stimulants to keep her up until the beginning of August, when she was put on drachm doses of bromide

of potassium thrice a day with scarcely any good effect. By way of experiment a drachm of tincture of cannabis Indica was added to each dose about the middle of August, and the effect of each dose of the mixture was quite marvellous. She at once became quiet, slept at night, took her food better, began to be industrious, and was sent to the convalescent ward, and to see whether this improvement was really due to the medicine it was discontinued and in two days she was nearly maniacal again. It was continued regularly for six weeks. She gained ten pounds in weight, and then began only to get a dose of the medicine when she felt her head getting confused. She used to ask for it to clear her head, and said its effects were "miraculous." She ceased to have the hallucinations. She remained in this state till December, requiring no medicine at times at all. At that time she began to get worse. She was then put on regular doses as before, and the attack was quite checked, but in January she got worse in mind and more stupid. She remained quiet till July following, getting the medicine regularly. It then lost some of its good effect, but still subdued the excitement.

It was through this case that my attention was first directed to the power of a mixture of tincture of cannabis and bromide of potassium to allay excitement of the brain. I never in my experience of over 2000 cases of insanity had seen anything so wonderful. It seemed a direct antidote to the morbid action of the cerebrum. I thought from the beginning that the woman had limited softening somewhere in the ganglia at the base of the brain. The contraction of the pupil, the small pulse, the hallucinations of hearing, and the unimpaired intelligence on many points seemed to point to some such lesion. If my diagnosis is correct, of course complete recovery could not have been expected. In no case in which I have given it since have I seen quite such good effects at once. Its sedative action I have seen as powerful, but it must be admitted that it is seldom, indeed, in therapeutics that we are able even temporarily to remedy a morbid action of the cerebrum so severe, so long continued, and so obstinate.

Insanity at the change of life.—A. H—, æt. 47, a married woman, who had lately ceased to menstruate, and who had been insane for three months; she had been restless, sleepless, noisy, complaining of all sorts of imaginary ailments, and had attempted to commit suicide.

On admission, she was depressed and restless looking. She complained of bodily weakness and many ailments. Pulse 75, good; temperature, morning, 97·3°, evening, 97·1°; weight, 130 pounds; no bodily disease to be discovered.

She remained from May till the following January in the state described. During that time she got various medicines, chlorodyne, Pil. Aloes et Fer.; quinine and iron, and Tr. Valer. co., but she got no

better. In January she was put on a grain of opium, three times a day. She was kept on this for about three months. It seemed to produce improvement, at first procuring sleep and allaying restlessness, but there was no permanent improvement in the mental depression. She lost six pounds in weight, and her average temperature rose ·9° in the morning, remaining the same at night while on the opium. In April she was put on half-drachm doses of bromide of potassium at bedtime. This at once procured sound sleep, and after about a fortnight the restlessness and depression were visibly allayed so that she could settle to regular useful employment. The medicine was continued till July, when she had gained more than a stone in weight, and was apparently well in mind. As the case had been so long insane she was kept in the asylum till September, 1868, in case of a relapse, was then discharged recovered, and has kept well since.

This is a good example of the good effects of the bromide alone in climacteric insanity. It is usually subacute in its character, and does not require such large doses. I was beginning to despair of seeing any improvement in the case when the bromide was tried.

General paralysis.—T. D—, æt. 50, in the end of the first stage of general paralysis. Before admission he had been much excited, and had all the characteristic delusions of the disease about his immense wealth, &c.

On admission his speech was affected slightly, and he had all the most characteristic symptoms of general paralysis. He became worse rapidly, getting more and more excited. He was exceedingly noisy by day and night, filthy in his habits, and so constantly attacking and interfering with other patients and attendants that it was nearly an impossibility to prevent him from being injured. Indeed, on two occasions he was severely hurt by fellow patients. There seemed to be no alternative between almost constant seclusion and the risk of accidents. In this state he was put on a drachm and a half of the bromide with the same amount of the tincture of Indian hemp thrice a day, and after he had taken it for two days he became quite manageable. After about a fortnight it was found necessary to reduce the quantity of the bromide, on account of the persistent drowsiness and the furred tongue it was causing; but five-grain doses, however, were given until that attack had passed off, and with the same sedative influence.

This case is merely a type of general paralysis in the excited stage. Such a patient is, without exception, the most troublesome class of inmate of an asylum.

Summary.—1. The preceding observations consist of three parts. 1st. Experiments to determine the effect on maniacal excitement of

single doses of certain medicines, stimulants, and food. 2nd. Experiments to determine the effect on maniacal excitement of prolonged courses of certain neurotic medicines. 3rd. An account of clinical observations and experience of the effects of the same medicines in all kinds of insanity.

2. To compare the effect of opium on maniacal excitement, with that of bromide of potassium, with that of cannabis Indica, and with that of a mixture of bromide of potassium and cannabis Indica, and to compare the effect of these with that of a pure stimulant in large quantity, and with that of a nutritive food, eleven maniacal patients were treated with drachm doses of each of the medicines, and with four ounces of whisky, and the beef tea made from a pound of beef on successive days, and the results noted. Each experiment was repeated from fourteen to twenty-nine times.

3. A mixture of one drachm of bromide of potassium with one drachm of the tincture of cannabis Indica is more powerful to allay such excitement than any of the other drugs or stimulants tried. It is more uniform and certain in its effects, more lasting, interferes less with the appetite; and to produce the same effect the dose does not require to be increased after long-continued use.

4. Single doses of opium tended to raise the temperature and to lower the pulse; single doses of the mixture above-mentioned to lower the temperature and quicken and weaken the pulse, of bromide of potassium alone to raise the temperature and lower the pulse, of cannabis Indica alone to raise the temperature and quicken the pulse, of whisky to lower the temperature very much and slightly to quicken the pulse, and of beef tea to lower the temperature in the least degree and to lower and strengthen the pulse.

5. By giving bromide of potassium and cannabis Indica together, not only is the effect of either given separately immensely increased, but the combination has an essentially different action from either of them given alone.

6. Bromide of potassium alone can subdue the most violent maniacal excitement, but only when given in immense and dangerous quantities, and its effects are so cumulative while so given, that after they have once begun to appear they increase for days after the medicine has been stopped, almost paralysing the cerebrum and sympathetic.

7. To produce sleep in mild excitement, one drachm of the bromide of potassium is about equal to half a drachm of laudanum. To allay maniacal excitement, forty-five grains of the bromide and forty-five minims of the tincture cannabis are rather more than equivalent to a drachm of laudanum.

8. Seven cases of chronic mania were treated for twelve weeks with opium, in doses rising gradually from twenty-five minims of the tincture up to ninety minims three times a day, and the results

noted. After getting no medicine for several months the same cases were treated with a mixture of bromide of potassium and cannabis Indica in gradually increasing doses, and the results noted and compared with those of the opium treatment.

9. Under the opium treatment the patients all lost in weight continuously; their morning temperature was lowered and also their evening temperature, but the latter (which was too high, and its being high was a bad sign) very slightly, and their pulse was decreased in frequency. The opium allayed the excitement in the larger doses, but it soon lost its effect.

10. Under the bromide of potassium and cannabis Indica treatment the patients only lost in weight very slightly for the first six weeks, and after that they gained, their weight being more at the end of eight months' treatment than it was to begin with. Their appetites were not interfered with. Their temperature fell, especially their evening temperature, and the pulse was slightly increased in frequency and weakened in force, while the excitement was subdued, and the medicine showed no signs of losing its effect, even after being thus used for eight months. The maximum of good effects and the minimum of the ill effects of a sedative drug were thus obtained by using the bromide of potassium and the cannabis Indica in combination.

11. The bromide of potassium alone may be continued for months in doses of half a drachm three times a day, and the patients gain in weight and remain healthy in body, but the proper dose, whether given alone or along with cannabis Indica, varies greatly in different cases.

12. Cannabis Indica being a diuretic, and the bromide of potassium being carried off by the kidneys, it is probable that the former in that way helps to prevent the cumulative action of the latter when given alone.

13. When the two are given together, the first symptoms developed are those of the cannabis Indica, but these soon merge into a state of drowsy calmness of the nervous system which is in all respects the opposite of nervous irritability.

14. Fifty-one cases of various forms of insanity were treated by bromide of potassium alone or along with Indian hemp, and the results were that eighty per cent. of these were benefited more or less in some way, and twenty-five per cent. were most decidedly benefited.

15. The milder cases of puerperal and climacteric insanity were sometimes remarkably benefited by drachm doses of the bromide of potassium given at night.

16. In some of the cases of acute mania the excitement was subdued in a few days by the bromide combined with Indian hemp in doses of from half a drachm to a drachm of each given three times a day.

17. In some cases of periodic mania and general paralysis all the worst symptoms of maniacal excitement were allayed by giving a mixture of bromide of potassium and cannabis Indica in doses of from half a drachm to a drachm and a half of each three times a day. This was continued in one case for nine months with the best effect.

18. In three cases of periodic mania, attacks were cut short by a mixture of the two medicines, or by the bromide alone. In one of these complete recovery followed.

19. Fewer cases of simple melancholia were benefited by the bromide alone or along with Indian hemp than any other form of insanity. Some were made worse by them, but in one case of this disease where there was great excitement and hallucination of hearing and suspected organic disease of the brain, the combination gave immediate and complete relief of all the symptoms for four months.

20. One case of senile mania was successfully treated at home by a mixture of the bromide of potassium and tincture of cannabis Indica, when she was to have been sent to an asylum. It seems probable that some such cases, and also patients with short attacks of mania might be treated by the same medicines at home, when at present they have to be sent to lunatic asylums, on account of the want of such a safe and powerful sedative.

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SEWAGE EXHALATIONS

THE

CAUSE OF DYSENTERY.

AN ACCOUNT OF AN OUTBREAK OF DYSENTERY IN THE CUMBERLAND AND WESTMORLAND ASYLUM, WHICH WAS CAUSED BY THE EFFLUVIA FROM A FIELD IRRIGATED BY SEWAGE.

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The Cumberland and Westmorland Asylum is built on a dry, sandy hill, about three miles from Carlisle. There are no manufactories or polluted streams near it. The subsoil of the land lying at the base of the hill on which it is built is a stiff brick clay. The water supply is derived from a small stream which arises from the drainage of neighbouring fields, and from several springs in those fields. The water was analysed before the site was determined on, and found to be very pure. The building is well ventilated, and the water-closets and drains were constructed on the most approved principles. Two of the soil drains, however, have frequently had to be taken up since the opening of the institution on account of being choked up when rags, etc., were thrown down the water-closets by the patients. The water from the baths and lavatories is not thrown into the sewage drains, it having been thought that the sewage would be too much diluted if mixed with it. The main drain conveys the sewage to a large vaulted close tank, 40 feet by 40 feet, and 6 feet 6 inches in height, situated about 150 yards from the nearest inhabited part of the Asylum—a small detached block—and 200 yards from the main building. It was intended that the sewage should be pumped out of this tank into carts, and so distributed over the land. The solid part was to be allowed to accumulate in the bottom of the tank, and to be cleared out through a man-hole at the top at periodic intervals.

The Asylum was opened in the beginning of 1862, and has since generally contained over 200 patients. Many of those, as in all Asylums, are paralytics, weak epileptics, and maniacal patients, whose nervous energy has been greatly exhausted by previous excitement. Many of the patients are old and weak when sent from workhouses to the Asylum. There are about thirty sane people connected with it as officials, attendants, and workmen. The regular diet of each male patient consists of 24 ounces of cooked animal food, 14 pints of milk, 16 ounces suet dumpling, 7 pints of oatmeal porridge, 78 ounces of bread, 7 pints of tea, and 3½ ounces of butter per week. The females have somewhat less solid food, and coffee as well as tea every day. Extra diet of all kinds is given to the sick and weak. Stimulants are only given by Medical order, not even beer being a part of the regular dietary of the patients or

their attendants. Each patient has from 500 to 900 cubic feet of air in the dormitories and single bedrooms, and more than this amount in their dayrooms.

During the first two years after its opening, the mortality in the Asylum was not half the average mortality in all the other county Asylums. No epidemic appeared in the Asylum till the end of 1863, when there were two cases of typhoid fever, one of which proved fatal. A source of contamination of the water supply was at that time discovered and remedied. It consisted of the contents of a drain which received the slops of half a dozen cottages and the washings of a few hundred yards of a public road. No water-closets emptied themselves into this drain. The cases of fever were of the ordinary type in all respects, and the post-morten appearances in the one that died were such as are ordinarily found in such cases. I attributed them at the time to the impure water. During the first two years after the opening of the Asylum, diarrhœa was not unusually common among the patients, not more than a dozen cases having been treated for it each year.

Towards the end of February, 1864, a patient who suffered from chronic pleurisy, and whose mental state was that of the most extreme dementia, was attacked by severe and prolonged diarrhœa, with some dysenteric symptoms. The dysenteric symptoms passed off, but the diarrhœa continued till he died, in June. This case attracted no unusual attention, until, in the beginning of April, three men were attacked with very severe dysentery within five days of each other. One of them was a general paralytic, in the last stage of the disease; the second had paralysis agitans in a severe form, and they both died within a week; the third was aged 81, and laboured under chronic mania, and he died in three weeks.

I shall describe the dysentery more particularly afterwards, however. It presented sufficiently marked and novel features to warrant a very full description of its pathology. In the meantime I shall confine myself to the history and etiology of the epidemic as an epidemic.

On May 8, two men were attacked by the disease, one of them an attendant, a young man in robust health, who had only been three days in the Asylum, and both ultimately died. No cases then occurred until June 3, when a woman was attacked by the disease, and, as she was previously phthisical, she very soon died. In the same month four other female patients were attacked, two of whom died. One of those who died was a deaf and dumb epileptic, of feeble nervous power; the other, an old woman of 65. Of the two who recovered, one was a woman who had been for a long time subject to severe dsypeptic attacks, accompanied by a tendency to diarrhœa, and the other was a previously healthy congenital imbecile. On July 2, a man was attacked and died. On July 6, two women were attacked by the disease, one of whom,

aged 66, previously exhausted by chronic mania, died, and the other, a congenital imbecile, recovered. On the 13th, a man and a woman were attacked by the disease, both of whom died. They were aged 73 and 66 respectively, and the man was partially paralysed. Between the 17th and the 22nd four men were attacked, none of whom died; but one of them was attacked again on August 2 and died. The disease was apparently checked at first by astringents and opiates in this case. On August 2, and on the 4th, two cases were attacked and both recovered. On the 7th a woman was attacked and died. This woman had been previously in good bodily health. From the 18th to the 23rd of August three cases were attacked, one woman and two men. The woman (a general paralytic) died; the two men, one of whom laboured under phthisis, recovered. These were the last cases that occurred in 1864.

Of the twenty-six persons attacked nineteen had been inmates of the wards on the ground floor of the Asylum. Eleven of them had slept in bedrooms on the ground floor. All the women attacked had been inmates of this ward, except one who lived in the detached block near the sewage tank. I may mention, however, that in the wards on the ground floor, the majority of the weaker, older, and paralysed patients reside, in order that they may have freer access to the airing courts.

On March 12, 1865, a woman was attacked by diarrhœa, which gradually passed into dysentery, with slight bloody and purulent evacuations; and on the 19th and 28th, within forty-eight hours four women were attacked with dysentery. All those five cases were in the ward on the ground floor. The four who were last attacked all died, although two of them had been previously in average health.

Altogether, therefore, thirty-one persons were attacked by dysentery, of whom twenty died.

During all this long-continued prevalence of the disease in the Asylum, I find from my prescription-book that diarrhœa was much more common than in the two previous years, but this is, no doubt, partly accounted for by the extreme vigilance of the attendants in watching for and reporting at once all cases that had the smallest symptom approaching a bowel complaint, and its immediate treatment by me. No doubt I treated many slight cases of diarrhœa that but for the prevalence of the epidemic I should never have heard of. But making ample allowance for these, ordinary diarrhœa was much more prevalent than usual. There were no cases of very severe and continued diarrhœa, however, that would not yield to treatment by astringents and opiates We shall see, when we come to describe the dysentery more particularly, that it seldom was preceded by long-continued diarrhœa, but in by far the majority of the cases appeared as dysentery almost from the beginning.

Cases of erysiplas were not more common than usual, and there was no other epidemic disease prevalent in the Asylum.

From the time when the first case of dysentery occurred, I endeavoured to discover the cause of the disease, well knowing that there must be a cause either in the unfavourable hygienic condition of the Asylum or in the food or water. The drainage was the first thing looked to. That, with the exception of the one drain that was frequently being obstructed to which I referred, was found apparently in a satisfactory condition. And the period when the patients were attacked with dysentery I found to bear no relation to the periods when the drain was obstructed and the ground, opened to clear it out. The whole Asylum was thoroughly and specially cleaned, and the water-closets kept sweet. McDougall's disinfecting powder was used largely whenever it could be applied. The bread, water, and milk were analysed by Dr. Macadam, of Edinburgh, and found to be free from any obviously deleterious matter. The water was made to pass through a charcoal filter, and boiled before being used for drinking by the patients. All the feeble patients were sent up to the upper wards; they were all made to wear flannel shirts and drawers, and the ventilation was increased by opening the upper sashes of the windows during the night. All those prophylactic means proved unavailing. Still fresh cases occurred, and I confess that I was almost hopeless as to discovering the cause of the epidemic. The soup which the patients had as part of their dietary was discontinued. All the patients in the lower wards had twenty minims of diluted sulpuric acid administered to them three times a-day, because during the cholera epidemic it had been recommended as a prophylactic for bowel complaints generally, but one or two of them were attacked while taking the medicine. The dietary did not seem to be at fault, for many of the weakly patients had been on quite a different diet from the ordinary patients, and yet took the disease. The want of stimulants did not seem to be the cause, for many of those same patients had been getting stimulants of all kinds in considerable quantity.

Although in the asylum there had been no other epidemic disease while the dysentery prevailed, yet in March and April three of the inmates of a cottage a few yards from the asylum had typhoid fever. The first of the three attacked had not been staying at home except on the Saturday and Sunday nights previously, and he was never brought home, but taken to the next village. A month after he was attacked the two inmates of the cottage who had always been living there took the disease. They had frequently been to see their brother while he was ill, and at the time I resolved that for the future I should always adopt the same precautions in the case of typhoid fever as in diseases usually supposed to be infectious.

It had often occurred to me whether the dysentery might not

be connected with the distribution of the sewage of the Asylum. I mentioned that this was thrown into a large tank, and that it had been intended to pump it up into carts to be distributed over the land. But this was found to be impracticable from the large quantity of sewage. An opening was therefore made in the upper part of the tank, and the liquid part of the sewage which overflowed at this opening was conducted by open cuts to irrigate about three acres of grass land immediately below it. The opening through which the sewage escaped from the tank was only about six inches square. The irrigated field was about 300 yards from the female ward in which the greater number of cases occurred, and 350 yards from the corresponding male ward. The land had been drained shortly before the Asylum was opened. The upper part of it had a sandy subsoil, and the lower and greater part of it had stiff brick clay under the soil. The direction of the cuts was often changed to make the sewage run on different parts of the field, but this was not done very scientifically.

The reasons which at first made me think the application of the sewage had nothing to do with the dysentery were these :— 1st. The sewage had been so applied for two years previously, during which there had been no epidemic diseases of any kind. 2nd. Sewage had been applied in much the same way in many other places, and I had not heard of any epidemic diseases being produced. Jock's Lodge Cavalry Barracks are situated by the side of an immense extent of land which is always being flooded by all the sewage of Edinburgh, and they are said to be the most healthy barracks in the kingdom. How could the sewage from a building with 250 people do any harm, therefore ? And at many Asylums I know the sewage to be used in the same way quite close to the building. 3rd. I had never heard of dysentery being connected in this country with sewage exhalations as a cause at all. 4th. I had never perceived any offensive smell at the house ; and 5th. Although a very offensive odour was perceived near the irrigated field, yet I was inclined to hold the views of Professors Christison and Bennett, of Edinburgh, as to the general harmlessness of stinks.

In the month of August, however, an offensive odour from the sewage was clearly perceived at the Asylum during several hot sultry evenings, and I considered it advisable to convey the sewage away from the tank in a covered drain to the boundary of the Asylum farm, where it is thrown into a deep ditch and largely diluted with water. After that time no more cases of dysentery occurred in the Asylum during the year 1864, and those at the time labouring under the disease recovered.

The sudden termination of the epidemic coincidently with the removal of the sewage exhalations at a time of the year when dysentery is beginning to be most prevalent, afforded a very strong presumption that the effluvia and the epedemic of dysentery were

cause and effect. The fact that the tank had not been thoroughly cleaned out for two years, and that the land was a stiff clay through which the sewage would not readily perculate, was strongly confirmatory in my mind of this view. But in order to apply what I considered to be a sure test, I made out a list of the days on which the patients were attacked by this disease, and sent them to a meteorologist well known in the neighbourhood for the accuracy of his observations—the Rev. F. Redford—asking him to tell me the direction in which the wind was blowing on those days. The irrigated field was to the north of the Asylum, and I expected to find that the wind had been blowing from that direction each day. I then thought that such a poison must be in operation up to the time when the disease begins. But the list was returned to me with only one day marked with a north wind. I then asked him to give me the number of times the wind had blown from the north during the fortnight previous to the outbreak of the disease. It had been from that direction in fifteen out of the twenty-two periods of attacks, and in all the cases it had blown for more than one day from that direction. But the seven remaining periods, which were all in July and August, when there had been no north wind, still puzzled me, until I remembered that it was during a sultry evening with no wind that the sewage smell had been perceived at the Asylum. On a more careful examination of the meteorogical record, I found that such evenings had preceded the outbreaks of the disease, not only in the seven cases unaccounted for, but also in many of the other cases when the wind had been blowing from the north during the day. A further examination showed that within a week of each outbreak of the disease there had been either north winds or hot sultry evenings, with no wind during the night. I also found that in the spring and early part of the summer when the outbreaks had occurred at one time on the male side of the house, and at another on the female side, and there were no calm evenings preceding, that the wind had blown from a point west of north before the male patients were attacked, and due north before the females were attacked. This was precisely what might have been expected, for the building stands east and west, and being a long building the wind would require to blow somewhat from the west to bring the effluvia to the male side. Indeed, it would seem that the number of cases attacked were in the ratio of the number of times the wind had blown from the north or the number of sultry evenings previously. Between April 5 and 14 three males were attacked, and the wind had blown from the north or north north-west at least twelve times from March 26 till April 14; and from the beginning of March up to the 9th, there had been several evenings quite calm, with a high barometrical pressure. This last condition I found to be very common during the fortnight preceding the attacks. It would obviously tend to prevent the diffusion of the effluvia through the atmosphere, thus keeping it

near the ground, and accounting for the great number of patients in the wards on the ground floor being attacked. Then on May 8 a male patient and the male attendant were attacked by the disease. I found that there had been four calm nights immediately preceding this date, and that the wind had blown twice from the north north west during the day. Again, on June 3, a woman was attacked, and another on the 9th. I find that the wind had several times blown from the north previous to those dates, and that there had been several warm, calm nights. Certainly no conditions could be more favourable for such a poison to produce its effects than when a warm night with a high barometrical pressure caused strong exhalations, while a gentle wind from the proper direction wafted them in through the windows I had caused to be opened to let in fresh air, to be breathed by my patients when they were asleep and most liable to their deleterious influence.

From the first of the season, up till July, when the direction of the effluvia would be determined chiefly by the wind, males and females were attacked at different times, according as the wind blew towards the male or female side of the Asylum; in July and August, when, through the sultry calm nights, with a high barometrical pressure, the effluvia would spread in all directions along the ground, males and females were attacked promiscuously.

Although I could no longer doubt that the sewage effluvia had caused the dysentery, yet I attributed this to the state of the sewage chiefly, and secondarily to the kind of soil to which it had been applied. As those who had houses further down along the stream into which the sewage was emptied objected to its being allowed to run there permanently, and as I believe, if it were properly applied, it would be harmless to the health of the inmates of the Asylum, I had the tank emptied and thoroughly cleansed. I was to have had the field better drained and levelled, and deeply trenched, so that the sewage might be spread over a larger surface, and applied more scientifically, and that the extra liquid might drain away. All this could not be done at once, and in the course of the operations the drain had to be taken up which conveyed the sewage from the tank. While this was up the sewage had to be accumulated in the tank when the wind was blowing from the north, and allowed to run off by a pipe from the bottom of it when the wind was blowing from other directions. But for one night this had been allowed to run on the land when, as I ascertained in the morning, the wind had been blowing towards the house. It had been nearly calm during the night, too, as I afterwards ascertained. In a week from that time those five cases of dysentery occurred. But another cause must have been in operation, for an obstructed drain was found near the ward in which the cases occurred, which had formed a little cesspool under the soil immediately below the windows of the ward. This can only have existed for a few days, until the soil was saturated and the water rose, as it did at last, into the water-

closets. The drain was, of course, at once repaired, the soil removed, McDougall's powder thrown in, and fresh soil was substituted.

This outbreak of dysentery was, therefore, in all points confirmatory of my previous conclusions as to the bad effects of sewage effluvia; but it showed that it was not necessary for that sewage to have been pent up in large quantity for a long time to become prejudicial to health. The sewage that was run over the land immediately before the dysentery broke out this time was fresh from the drains, the tank having been thoroughly cleansed out. The land to which it was applied had had no sewage applied to it for some time, but, in afterwards trenching this land, it was found that the sand from the upper part of the field had completly obstructed the drains through the clay, so that it had been, latterly, at least, as if it had never been drained.

Shortly before this time one of the men employed by the Asylum had involuntarily made himself the subject of an experiment showing the poisonous effects of sewage gases. He was putting a new tile in a drain, and happened to put his head close to its mouth, breathing a quantity of the foul air that emanated from it. For the next four days he felt languid, had no appetite, felt very cold at times, had a sensation of something in his throat which made him swallow, and often had the sensation of smelling the drain again. He then was seized with severe pain in the abdomen, as if his "inside were being twisted out." This was shortly followed by vomiting and severe diarrhœa. He says the matters vomited smelt of the drain, and the dejections were very fœtid and of the same odour. He then had a pinched look, his tongue was coated with a thick, dirty, yellowish fur, his breath was offensive, his pulse was quick and feeble, and he could take no food. The diarrhœa continued and became worse, till he could scarcely leave the water-closet, and the evacuations were slimy and mucous, and were slightly tinged with blood, while he had a great straining at stool. During all this time the pain was very intense in the abdomen. He said he felt as if his inside were all going away. He had been taking Dover's powder from the time the diarrhœa became very severe, and he seemed to think that on the second day, when the blood appeared in his stools, the powders relieved the pain and lessened the diarrhœa; which continued in a less severe form, however, for two days longer, with no blood in the dejections. It then ceased, leaving the patient weak for another fortnight. The day after the diarrhœa ceased he had very great difficulty in micturition.

This man had not slept in the Asylum, but three miles away from it; he had been in every respect, a strong healthy man previously, and there had been no cases of severe diarrhœa or dysentery in the Asylum for four months previously. It therefore seems certain that the foul air he breathed from the drain was the

cause of his illness; and we shall see, when I describe more fully the dysentery which occurred among the patients, how much his symptoms resembled theirs. This is, therefore, a most instructive case.

As to the extent to which diarrhœa prevailed among the attendants, and servants, and officials in the Asylum during the period when dysentery was prevalent, I find that at least a dozen of them had it in a more or less severe form. In some cases it was coincident with the outbreaks of dysentery among the patients. Many of them had never had such attacks in their lives before. It seems reasonable to infer that the poisonous effluvia which in the case of the patients and the one attendant caused dysentery, was got rid of more easily in the other cases, and merely caused diarrhœa, just as it did in the workman's case who breathed a whiff or two of the undiluted air from the drain. Another curious fact, that may have reference to the action of the poison, is, that at the time when the last five patients were attacked by dysentery this year two other women in the same ward in which they resided (that on the ground floor), who had had dysentery last year and recovered, were observed to lose their appetite, to become listless, and to cease to occupy themselves. They were both imbeciles, and could not describe their sensations; but this state continued a fortnight, when they again resumed their usual condition. All this time they had been getting quinine and iron. They had no diarrhœa. Does not this point to the influence of the same poison on persons who had become somewhat inured to its influence, and on whom, therefore, it had lost its full effect?

As the sewage effluvia had evidently produced the dysentery, I began to think that it might have had something to do with the typhoid fever too. The first inmate of the cottage attacked was only at home on the Saturday nights and Sundays. On the Saturday and Sunday nights, March 19 and 20 (he had been attacked on the 22nd), the wind blew from the east and north chiefly, and the nights were calm. This direction of wind would not bring the effluvia to the cottage, and it is unlikely that the calm would be so complete at that time of the year that the effiuvia would spread in all directions; but on the previous Saturday and Sunday nights the wind had blown from the N.W., veering to the W.S.W., which would be the precise direction to bring it to the cottage. He would breathe the effluvia for two nights, nine days before he had been attacked by typhoid fever. The other two inmates of the cottage were attacked on April 17, and up to April 9 from the 5th there had been calm nights with a high barometrical pressure, and the wind blowing from the N.N.W. They, too, had certainly been breathing the effluvia for four days and four nights eight days before they were attacked; and I also find that though there were no north winds in the fortnight preceding the time when the two patients were attacked with typhoid fever in the Asylum

on October 29 and December 1, 1863, yet in the fortnight preceding the former period there were seven perfectly calm nights, with very high barometrical pressure and five such nights in the fortnight before the latter date, which is certainly an unusual circumstance at that season.

I have endeavoured to find out the period of incubation of the poison, during which it was in the system before it produced the dysentery. If north winds and calm evenings had occurred singly, this might have been done accurately, but in most cases the effluvia was breathed for two or three days at a time, and taking the period of fourteen days before each case was attacked, I find that in that time the cause had been in operation more than once. That the poison produced the disease in three days from the time of its inhalation, I have positive evidence in the case of the attendant, who had only been in the house for that time, when he was seized with it. The sewage exhalations had been breathed by him during all that time. Then there were four days of incubation in the case of the workman who breathed the gas contained in the drain. One of the patients was attacked on June 18, and for three days before that the wind had been blowing briskly from the south west, so that in this case there must have been at least three days of incubation. Another case was attacked on June 13, and there had been no north winds, or periods of absolute calm for five days.

In regard to the five cases attacked this year, it was six days from the time when the sewage had been running over the land during the night, with a north wind blowing, until the cases were attacked, but during the four succeeding nights there had been an absolute calm, so that any effluvia still rising from the ground would be breathed by the patients. And then there was the obstructed drain, which was obstructed up to the time when the patients were attacked. It would seem that the sewage poison took from three to six days to produce the dysentery after it had been inhaled. It is quite impossible to say that in some cases it may not have produced it in less time. My experience does not determine that point.

In one case the action of the poison seemed to be hastened by a dose of castor oil, which had been given to overcome constipation; for the ordinary purgative effects of the medicine passed into a severe and fatal attack of dysentery.

My friend the meteorologist informs me that the occasions during which the wind blew from the north before the outbreaks of dysentery were almost the only occasions on which the wind had been from the north.

The Dysentery.—The type of dysentery which occurred here was so different in many respects from any of the accounts of dysentery with which I have met, that I think it demands a full description. In many of its symptoms, in the treatment

most successful for it, and in its pathology, it differed widely from tropical dysentery.

All the cases did not commence in precisely the same way. Some of the patients had ordinary diarrhœa from periods varying from two to three hours up to twenty-four hours before blood appeared in the stools. In some cases there was great pain in the abdomen for twenty-four hours before the diarrhœa set in; in other cases there was scarcely any pain at any period of the disease. In some cases there were febrile symptoms at the beginning; in others these were absent till the disease had advanced considerably.

There were two classes of cases. In the first, the patient had two or three loose stools, or perhaps had no ordinary stools at all, but at once began to pass glairy mucus mixed with blood, in small quantities at a time, from the bowel. He had no pain, no fever, no want of appetite, and he refused to believe he was ill. This would continue for a day or two, and then the blood would increase in quantity, and the stools become more frequent. Pain would begin to be felt in the region of the rectum, and the pulse would mount up ten or twelve beats. For days the patient would be at stool every hour or two, and of course would become weaker. His tongue was then seen to be coated with a dirty yellowish white fur, but the appetite for such forms of nourishment as milk, strong beef-tea, calves-foot jelly made with wine was good. Solid food was not relished. The stools would then be seen to be coated with a semi-fibrinous semi-purulent looking membrane. The tongue would then become clean and glazed and beef-steaky; the evacuations become fæculent, mixed with pus, the latter element becoming gradually less as the patient advanced in his slow convalescence.

In the second class of cases, the patient had from the first great pain in the abdomen of a griping kind, a hot skin, and a pulse over 100; the dejections were copious and frequent and watery, while they were largely mixed with blood. In many cases there was sickness; in all loss of appetite. After some days the tongue and mouth would become dry and parched and black; the features pinched; the pulse small and quick; and death soon ensued. In some cases the stools would, after a time, become membranous and shreddy, and then purulent, till the patient was more gradually weakened and exhausted. One such case lived six weeks, and the attendant lived two months. Of course, this greatly depended on the previous strength. In only one of the seventeen cases of this class did the patient recover.

All the cases had the following features in common: bloody stools at first, tending to become purulent, intense fœtor of the evacuations during the whole of the disease, no scybala, and great thirst. The laundress could not wash the soiled linen without vomiting, until it had been deodorised by chloride of zinc.

As regards the previous bodily health and condition of the cases attacked by the disease, it may be best judged of when I mention that, of the thirty-one cases, only eleven had been in really good health. All the patients first attacked were very weak or very old. The attendant was the only exception to this. The disease did not confine itself to patients labouring under any one form of mental disorder; but it is remarkable that, though there are only, on an average, about eight patients in the Asylum labouring under general paralysis, three of these should have died of dysentery, and out of about the same number of congenital imbeciles and idiots, four should have had the disease. It would seem, therefore, that the chief predisposing cause of the disease was diminished nervous energy rather than impaired nutritive power, for several of the patients, especially those congenital cases, were fat and well nourished.

The high rate of mortality must be looked upon as owing quite as much to the state of the patient attacked as to the fatal character of the disease. But then the attendant, who had been strong and vigorous in every respect, was carried off by it, although he was removed away from the Asylum, showing that its fatal effects were not owing to weakness or impaired nutrition entirely; and one old man of 65 recovered, showing that the disease might assume a very mild form indeed.

I have no evidence whatever that the disease was infectious. The outbreak of the disease at first, the outbreaks in wards the patients of which had had no communication with the wards in which the dysenteric patients had been, the long intervals when there were no cases in the house, and the fact that the attendant who took the disease did so after three days' residence, when there were no cases in the house, and the entire immunity of the nurses who specially attended the sick, changed their linen, bathed them, etc.—all those facts go to prove nearly conclusively that the disease was not infectious.

Treatment.—In treating the first cases of the disease I naturally used opiates and astringents. I found them to be of no service whatever in the first stages of the disease The opiates decidedly did harm in any form given by the mouth, except Dover's powder, as they caused sickness. The astringents were useful in the latter stages of the disease, and I should be at a loss to say which of the numerous vegetable and mineral astringents I found most useful, for I found each of them useful, when first given, for a day or two, but they then lost their effect. During the stage when the evacuations were purulent and the blood in them disappearing, I found it of much service to give tannin, gallic acid, acetate of lead, sulphate of copper, sulphate of zinc, nitrate of silver, alum, logwood, and powdered cinchona in this way. Decoction of pomegranate root I found of no service. The famous ipecacuanha treatment, so universally practised, and so

implicitly relied on in the treatment of tropical dysentery, I tried in every possible way. So far as I could judge, the results were, that in a few cases it caused vomiting that could not be stopped, and prostration that was never rallied from; in a few cases it caused no sickness even when given in large doses, and then it diminished the quantity of blood in the evacuations, while, in the majority of cases, it caused temporary nausea, without doing any more harm or any good. I gave it in the very first stages of the disease, often both by the mouth and the rectum. I gave it in all doses, from a drachm down to ten grains. I gave it alone and in combination with opium, and after opium. I gave it once a day, and I repeated it every two hours in different cases, and the above is the unsatisfactory conclusion I must come to. Purgatives I found to aggravate the disease most unmistakably. Enemata of astringent substances I found useful in the latter stages of the disease in the cases that were going to recover, and a little opium with these increased their good effects. Enemata given by the long flexible tube, recommended by Mr. Hare, aggravated the symptons, or rather the flexible tube in being passed up the inflamed and irritable rectum caused intense and unbearable pain. I tried iron in the form of the tincture muriate and of the solution of the persesquioxide with as little good effect in the first stage of the disease as the other remedies. Creosote given by the mouth diminished the sickness in many cases, and also diminished the fœtor of the evacuations. Tincture of iodine was also ineffectual. Large doses of quinine were tried, but ineffectually. Chlorate of potash was also tried unsuccessfully. Diuretics were also tried in the cases where the urine was scanty and deposited urates, but they seemed of no service. Blisters over the abdomen were useless. The only plan of treatment that I was quite sure did the patients good was to remove them to the third story, to give them as much nourishment in a liquid form as they could possibly be got to take, and to give them wine and water *ad libitum*. Large vessels of milk, boiled with a little flour, and allowed to cool, were always kept by the patients day and night, and the nurses were ordered to give them some of this as often as they could be got to take it. Small pieces of ice were always grateful to them, and when there was nausea or vomiting helped to allay it. Strong beef-tea was given *ad libitum* to those who could be got to take it. Calves'-foot jelly made with wine was given to those who would take it. Soft boiled eggs in some cases were taken and did not increase the purging or cause pain after they were taken. But of all the forms of nourishment the boiled milk was taken most readily by the greater number of patients, and kept up the strength best. This was Sydenham's most trusted form of nourishment in the dysentery of his day, and certainly I found it by far the best. Patients would take it when they would take

nothing else, and it never caused griping or an increase of the dejections, as any kind of solid food was so apt to do. During convalescence I did not find solid animal food in the least objectionable.

In three of the cases the patients got out of bed too soon, and had relapses of the dysentery, and then astringents were decidedly beneficial. They seemed to subdue the symptoms at once.

The cases varied extremely in the time they took to recover completely. One man recovered in a week, another was two months ill. The average duration of the disease was about five weeks. This includes the time during which the preceding and succeeding diarrhœa lasted. None of the patients who recovered had bloody stools more than a month.

Of the patients who died one lived four months, but in his case the cause of death was a sequela of the disease, and the ulceration of the gut was found cicatrising after death. Another case (the attendant) lived two months from the commencement of the disease. Several of them lived a month. A week was about the average length of time, and one case died in two days. All the patients who died in the short periods had been in weak health, or laboured under some other disease previously.

If I had now a case of the first type to treat, I should give Dover's powder in ten-grain doses three times a-day, and a large enema every morning containing a drachm of ipecacuanha and two drachms of compound kino powder, till the blood in the evacuations became very small in quantity, and pus had made its appearance. I should then give astringents in the ordinary medicinal doses, continuing each for two days only, till the patient was well. If I had a case of the second type of the disease, I should give ipecacuanha in small doses tentatively; and if it caused sickness, I should try quinine and astringents, to satisfy my conscience; I should give all the liquid nourishment and stimulants I could get the patient to take, believing that if he had any chance of recovery they would enable him to have it; but I should give the patient up as incurable from the first.

Pathology.—The morbid appearances found after death are the most distinctive and interesting features of the disease. Of the twentycases who died, I performed post-mortem examinations in sixteen. Some of the cases were in the very first stage, while the others were in all the intermediate stages, and in one case I saw the state of the intestine after it had healed; but perhaps I had better describe a typical case first, and afterwards mention the varieties. In such a case all the abdominal organs would be found healthy until the small intestine was examined. This, too, would be normal up to within five or six feet of the cæcum. The mucous membrane would then begin to appear reddened in small spots or rings round the gut. Six inches further down, the redness would

be universal, and the membrane would begin to be thickened and corrugated into folds like small valvulæ conniventes. A few inches further down, a yellowish, dirty-looking deposit would be seen over the mucous membrane in rings, very thin where it began, but gradually becoming thicker and more continuous till near the cæcum, it would be one-eighth of an inch in thickness. The swelling of the mucous membrane would also increase downwards, and the artificial folds running across the gut become more prominent. These, with their coating of deposit, made the inside of the bowel look like a series of thick transverse ridges covering its entire surface. This deposit when examined would be found to be soft on the surface, but getting more firm towards the mucous membrane, with which it incorporated itself, so that it could not be scraped off without leaving the fibrous covering of the muscular coat exposed, as a highly vascular, raw-looking surface. This deposit though on the surface a soft lymphy-looking substance, yet towards the mucous membrane it assumed quite the consistency and appearance of a soft fibrous membrane. The cæcum when examined in such a case would be found in the same state as the lower part of the small intestines, with two or three ragged ulcerations the size of beans; in the ascending colon the ulcerations became deeper and larger, while the lymphy deposit on the surface of the mucous membrane became thicker and more fœculent in colour. Towards the transverse colon the inside of the gut was one mass of large irregular ulcers, with patches of the deposit between them. The colour of the whole surface was almost black, and this continued down to the very lower part of the rectum.

The mesenteric glands opposite the affected parts of the small and large intestine were enlarged and dark coloured, and on section were soft, and pulpy in consistency.

Such were the external appearances in a case that had lasted for about a month. On examination of the fibrinous layer by the microscope, in the fresh state, it was found to consist of nucleated cells like pus cells, fusiform cells with nucleus, and a fibrinous material between. When a small portion of the gut was hardened in absolute alcohol or dilute chromic acid, and thin sections made of the gut transversely, showing all the coats, the peritoneal coat was seen to be normal, the muscular coat also normal, except that part of it in proximity to the mucous membrane, which was more than usually vascular. In the fibrous and mucous coat the blood-vessels were enlarged and very tortuous, and on the free surface of the mucous membrane between the villi they could be seen torn and open-mouthed. The villi were enlarged, stripped of their epithelium, and lying in contact with them and dipping in between them were the fusiform and round nucleated cells. The fusiform cells predominated near the villi. Minute fibres radiated from the villi through the layer of lymphy substance, branching

out and losing themselves at the free surface. Those fibres seemed to bind together the cells, and when a section through the deposit was made on the same plane as the surface of the mucous membrane, an areolar appearance was seen, the meshes being filled up with cells.

One woman died after two days' illness, and after death the solitary glands in the last part of the small intestine were found enlarged. Peyer's patches were quite unaffected; in the cæcum the mucous membrane was reddened and thickened in small patches running into each other, like the eruption on the skin in measles. In the transverse colon the whole mucous membrane was mottled and thickened. In the descending colon and rectum the mucous membrane was less diseased. In the rectum the mottling was mixed with small red points like pins' heads. There was no trace of ulceration anywhere. In this case there had been copious bloody evacuations. The torn capillaries, even where there was no actual ulceration, would of course account for the bleeding. There was no membranous deposit.

In a case which had died in five days from the commencement of the disease the mucous membrane of the small intestine was for six feet above the cæum reddened, thickened, and thrown up like valvulæ conniventes, with a little deposit on them. The mucous membrane of the large intestine was completely covered with a thick layer of the yellowish lymphy matter described.

In another case that died a week after the commencement of the disease, the small and large intestines were affected as in the last case, but the rectum was more affected, and looked as if the small blood-vessels were hanging loose in the fibrinous deposit. In a case that died eight days after the commencement of the disease, ulceration was commencing in the cæcum and sloughing in the colon. The description of the typical case may be taken as the next stage of the disease. In a very severe case which had lasted six weeks the whole of the large intestine of a dark colour externally, but not rough, and no effusion on the peritoneum. The interior was a raw, irregular, black surface; the walls were very much thickened, the muscular coat being thickened too, with inflammatory products, and the gut was so friable that almost the least current of water tore it up. In the rectum, blood clots projected from the open mouths of arteries.

Then the healing process was seen in the case of a man who was recovering slowly from the dysentery when he was carried off by pleurisy. In this case the small intestine was normal; but in the cæcum there were small dark-coloured depressed patches, with puckered margins. In the rectum there were healthy granulating ulcerations of a dark colour.

The series of dissections taken along with the symptoms during life enable us to follow the course of the disease as well

as if the inside of the gut had been visible. First, we have inflammation of the mucous membrane of the intestine, commencing in the solitary glands of the ileum, and immediately spreading all over it. In the large intestine it commences all over the surface, not selecting any special element of the membrane. Had it not been for one or two cases, in which the solitary glands of the small intestine were affected first, I should not in any of the other cases have been able to say which element of the membrane was first affected. Then we have the inflammation, immediately followed by a lymphy deposit on the membrane. Then we have the ulceration commencing in the small intestines in the solitary glands, not as pustules at first, as some writers affirm always happens in dysentery. In the large intestines the ulceration tends to commence by portions of the membrane sloughing. The capillary vessels all over the inflamed surface from the beginning seem to lose their tone, and many of them to rupture. The contact of the poison as it is being eliminated seems to paralyse them, while it stimulates the nervous ganglia contained in the intestinal walls, causing continuous action of the bowel of a very severe kind. In the cases which recovered we have the fibrinous membrane thrown off in large shreds, as seen in the evacuations, and then we have a granulating healthy sore, which discharges pus till it heals. I cannot account for the tendency to blackening of the surface of the membrane in all the cases.

In some cases the progress of the disease was much more rapid than those I have mentioned. In one case I found the whole of the mucous membrane of the large intestine in a sloughy state after five days' illness. In two cases the small intestines were affected as far up as the junction of the jejunum and the ileum. In two cases there were ecchymosed spots on the mucous membrane of the stomach, and two other cases in which the membrane of the stomach was inflamed and thickened like that of the small intestine. In three cases the small intestine was healthy in appearance, but one of those was the case that was recovering, and died of pleurisy. Another was a case that died of abscess of the liver, after the disease of the bowel had showed signs of improvement, and the third died in a few days from the commencement of the disease. In the first two cases I have no doubt it had passed off, and in the third, contrary to the usual state of things, the larger intestine had become affected first, and the patient being weak, died before the ileum was affected by the disease. The case I have just mentioned, in which there was abscess of the liver, was the only one with this lesion, and it may have been the result either of the dysentery or of the total obstruction of the common bile duct by a large gall-stone which existed.

The pathological appearances I have here recorded are very

rarely to be met with, and I have only been able to discover three recorded outbreaks of dysentery, in which they were at all similar. The one was the epidemic of dysentery that was so fatal to the British troops in the famous Walcheren expedition. Some of the cases recorded by Dr. Davis bear a close resemblance to the cases I have described. In an epidemic of dysentery which occurred at Prague, Dr. Finger records somewhat similar pathological appearances. In two of his 231 cases the jejunum and ileum were affected, and not the large intestine, and these he calls intestinal catarrh. He examined the exudation in his cases by the microscope, and found its structure to be somewhat the same as I have described in my cases. Dr. Mayne found in an epidemic which occurred at Dublin that the most rapidly fatal cases had an exudation on the surface of the mucous membrane, which could be easily scraped off. I had met with three similar cases previously, one in the Edinburgh Infirmary and two in the Royal Edinburgh Asylum.

In no case did I notice the pustular appearance of the glands noticed by so many writers, and I think the record of the pathological appearances and causes of the disease prove that Dr. Baly came to a conclusion from too limited experience when he said that all the forms of dysentery described by systematic writers are merely different stages of the same disease, and that the specific virus which he considered was always the cause of it was always derived from the soil. In its pathological appearances the dysentery I have described bears a much greater resemblance to that form of the disease caused by or connected with malaria than to tropical dysentery. The small intestine is sometimes affected in dysentery that has a malarious origin; but never in dysentery from other causes. But in no epidemic of dysentery of which I have ever read was there a tendency in all the cases to disease of the small intestine. The poison did not cause its effects at once, while it seemed to have no regular period of incubation, like the continued fevers, and unlike most of them it was unaccompanied by a skin eruption. In these respects it resembled malaria. The dysentery resembled ague, too, in having no fixed period of termination; but then it resembled typhoid fever in being accompanied by a specific lesion of the lower part of the intestinal mucous membrane.

The whole of the facts I have stated, and the inferences from these facts, may be thus briefly summed up:—

1. An epidemic of dysentery of a very fatal character occurred in the Cumberland and Westmorland Asylum, in the year 1864-65.

2. All the positive evidence that can usually be produced to determine the cause of any disease can be produced to connect this epidemic of dysentery with exhalations from a field irrigated by sewage, as effect and cause. Ample negative evidence can be

produced to show that no other probable cause of such an epidemic was in operation.

3. The old, weak, paralysed, and diseased patients were chiefly attacked, but it was not confined to them.

4. The majority of the patients attacked were inmates of the wards on the ground floor of the asylum, shewing that the sewage effluvia is most concentrated near the ground. Little or no wind and a high barometrical pressure would seem to be the most favourable conditions for the injurious effects of the poison to manifest themselves.

5. It would seem to be unsafe to apply sewage not deodorized to land with a stiff clay subsoil within 350 yards of human habitations.

6. Diarrhœa in its ordinary form may also be caused by sewage exhalations.

7. There are strong reasons for believing that the sewage effluvia which caused dysentery and diarrhœa in some persons may have caused typhoid fever in others.

8. The sewage poison had a period of incubation in most cases before the dysentery appeared. The length of this period was probably from three to five days.

9. The dysentery was of a very fatal character, and the ipecacuanha treatment, so successful in tropical dysentery, was not so in this epidemic.

10. The two morbid appearances most characteristic of this epidemic were, 1st. a soft membraneous deposit on the mucous membrane of the intestines; and 2nd, the diseased conditions of the lower part of the small as well as the large intestines in all the cases.

11. The poison which caused the dysentery seemed to occupy an intermediate position between the poison which causes the continued fevers, and that which produces ague and its concomitants.

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THE

MINUTE ANATOMY AND PHYSIOLOGY

OF THE

NERVOUS SYSTEM IN THE LOBSTER

(ASTACUS MARINUS).

BEING PART OF A GRADUATION THESIS PRESENTED BY THE AUTHOR TO THE UNIVERSITY OF EDINBURGH, ENTITLED "CONTRIBUTIONS TO THE MINUTE ANATOMY AND PHYSIOLOGY OF THE NERVOUS SYSTEM, AS ILLUSTRATED IN THE INVERTEBRATA," FOR WHICH HE RECEIVED ONE OF THE GOLD MEDALS AWARDED BY THE MEDICAL FACULTY.

BY

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THE MINUTE ANATOMY AND PHYSIOLOGY OF THE NERVOUS SYSTEM IN THE LOBSTER.

(The following paper formed a part of the Graduation Thesis presented by the author to the University of Edinburgh, entitled "Contributions to the Minute Anatomy and Physiology of the Nervous System, as illustrated in the Invertebrata," for which he received one of the Gold Medals awarded by the Medical Faculty.)

Believing that the simpler the structure and motions of an animal are, the less complex will be the nervous mechanism by which those motions are stimulated, I have selected the lobster (*Astacus marinus*) as the subject of the following observations. It approaches more nearly the simple articulated type in the length of the body and the distinctness and equality of its segments than any other animal of its class sufficiently large and sufficiently procurable in this country. Its nervous ganglia, therefore, combine the three elements, of large size, firm consistency, and distinct separation from each other. These advantages have not been overlooked by previous investigators, for Newport examined most carefully the structure of the nervous system of the lobster, and greatly advanced our knowledge of the subject.* He demonstrated the course of the nerve fibres as they enter the ganglia from the peripheral nerves; and if he was mistaken in his idea that there were two columns in the central part of the nervous system, a motor and a sensory, and came to wrong conclusions about the structure and functions of the ganglia,† it is more to be attributed to the backward state of physiology and histology at the time than to any want of acuteness on his part. Valentin adopted a different plan from Newport, and arrived at more correct conclusions.‡ He experimented on the river crayfish (*Astacus fluviatilis*) by vivisection; but to infer its structure from the phenomena observed after sections and

* Philosophical Transactions, 1834.

† See Dr Carpenter's "Inaugural Dissertation on the Physiological Inferences to be deduced from the Structure of the Nervous System in the Invertebrated Classes of Animals," and his Comparative Anatomy.

‡ Valentin, De Functionibus Nervorum, p. 8.

mutilations of the nervous system, is neither so satisfactory nor so sure as to demonstrate that structure under the microscope. The inferences can only extend to generalities, and in many instances the effects of a section may admit of more than one explanation. Dr Ernst Hæckel, in an inaugural dissertation on the tissues of the river crayfish, devotes a chapter to the minute anatomy of the nervous system, describing both the cells, and fibres, and neurilemma,* but did not attempt to describe the arrangement of these in the ganglia.

Different methods of hardening and preparing the nervous system have been recommended and employed by different observers. The central chain of ganglia must be carefully dissected out first, and the nerves springing from them left pretty long, so that the ganglia may be held steady while sections are being made. As much of the surrounding tissue must be removed as possible, and it is well to select a live lobster, as the nerve tissue is the first to soften after death. I tried numerous methods of hardening the tissue. That recommended by Van der Kolk, of first hardening it in spirit of wine, and then applying chloride of calcium to the sections, I did not find to be successful. The tissue was made too transparent, so that the fibres could scarcely be distinguished from each other, and the nerve-cells could not be made out at all. The method of hardening the ganglia in a weak solution of chromic acid (4 grs. to the ounce of water), and then making the sections transparent by applying a strong solution of chloride of calcium, I found to be by far the best. They must not be allowed to remain in the acid solution for more than eight or ten days or they will get friable, and generally they are sufficiently hardened to be cut into thin sections after four or five days' immersion. After the ganglia have been taken out of the chromic acid, they ought to be put into a weak solution of bichromate of potash ($\frac{1}{100}$ or $\frac{1}{200}$ to 1 part of water). After the sections are made they must be allowed to steep in water on the slide, to get rid of the chemical reagent that has permeated and hardened them. If this is not done, crystals form after the addition of the chloride of calcium, and obscure the section. This obvi-

* Müller's Archives, 1857. Dr E. Hæckel,—"Ueber die Gewebe des Flusskrebses."

ates the objections urged against this method by Van der Kolk. I found it most convenient first to dry up the water round the section after having placed it in the middle of the slide, then put on the covering glass, and place a drop of the solution of chloride of calcium at the edge of the cover, which soon finds its way to the section, making it very transparent, without destroying the distinctness of the outline of a single cell or fibre. There is still enough of the brown colour produced by the chromic acid left to give definition and sharpness to them. The residue of the chloride of calcium solution may then be wiped away by blotting paper, and the cover luted by applying two or three successive layers of asphalt in solution.

The sections may be coloured by being placed in a watch-glass containing a weak solution of carmine; and if they are then placed on the slide and treated with chloride of calcium, as I have described, the cells and fibres, and the relation of these to each other, may be seen very beautifully. The advantage of thus colouring them is not great, however, as regards the definition of structure, as compared with the simple method.

I also tried to put up sections, both coloured and uncoloured, in Canada balsam, as recommended by Lockart Clarke,* but they generally became too transparent; and even when this was not the case, the advantages of this method over the other did not appear to me at all to compensate for its greater difficulty. I am willing to admit, however, that this may have been the result of my own inability to apply this method properly. Certainly it appears to have a great advantage in the case of vertebrate nervous tissue.

Even with the best of these methods great care is required, both in making the section, and after it is made, not to injure it. The ganglionic matter is much more lacerable than the fibrous; and even when as hard as chemical re-agents can make it, plenty of spirit must be poured on the upper surface of the razor, so as to float the section as it is being made; and after having been transferred to the slide, if water be added too suddenly to the spirit, the section whirls about and is frequently broken up. A considerable number of mishaps

* Phil. Trans., 1859. Part I., p. 458.

will occur to what appear to be good sections, even in the most careful and practised hands.

The Investment of the Nervous System.—In the lobster the immediate investment of the ganglia and inter-ganglionic cords consists of a membrane somewhat like the corresponding structure in the peripheral nerves of the vertebrata. Taking the invertebrata generally, the density and thickness of this structure is in proportion to the amount of support given to the body of the animal by its external investiture. In the lobster, with its hard shell, it is comparatively thin; in the talitrus, with its horny plates, it is fortified with an additional cellular layer outside the fibrous one; in the leech, with no protecting material except a tough skin, there is a special dense covering of at least twice the thickness of the tissue it protects; and in the limax, the neurilemma contains a cretaceous deposit. In the fresh state, like the nervous system of the lobster itself, this membrane is semi-transparent; but after being hardened in chromic acid, I found it to be composed of two distinct layers of fibres,—the external running longitudinally, and the internal running transversely round. Each fibre is very distinct, and there are a few nuclei among them. In a very thin cross-section of a ganglion, the sheath presents an appearance like that represented in Plate I. fig. 1. The outer layer is then seen like a bundle of rods cut across *a*, and the limit between them and the transverse fibres is very well defined. This sheath sends in septa through the ganglia, as well as among the fibres in the inter-ganglionic cords.

Investing the two cords that connect the first thoracic to the cephalic ganglion, there is, in addition to the sheath I have described, a cellular layer. The cells have very thin walls, are pressed into hexagonal forms, and remind one of the cells in the loose pith of some plants. At the root of the pneumogastric this substance is of unusual thickness, forming an investment much thicker than the nerve substance proper. Its existence is accounted for by the fact, that the cords at that part pass through what corresponds to the pleural cavity, and require a special investment to make up for the want of support on either side.

The Nerve-Fibres.—Hæckel describes and figures the nerve-

fibres of the river crab as simple tubes of different sizes, having diffluent contents, frequently dividing, and having nuclei in their walls. The nerve-fibres are very large, but irregular in size, in most of the nerves of the lobster, and present a double outline,—not of the same character as the double outline of a mammalian nerve-fibre, but two equally distinct lines very close to each other, indicating that they are tubular. Some of the smaller ones, where the wall of the tube is very thin, do not show the double outline. Their average size is about $\frac{1}{500}$ of an inch in diameter, but there are many large fibres $\frac{1}{250}$ of an inch in diameter.* These large fibres were observed by Ehrenberg, and fully described by Remak in other allied species of the Crustacea. In fresh specimens they resemble blood-vessels, for which at first, indeed, I took them. Leydig made a similar mistake, but at length came to the conclusion that they were really nerve-fibres.† He figures these fibres, along with others minutely fibrillar, from the river crayfish.‡ I have repeatedly seen the same appearance in the lobster, and have one section of a cord connecting the first thoracic to the cephalic ganglion, which might almost have been the original from which Leydig's drawing was made, so similar is it, but this section happens to be cut very thin at one end, so that the fibres can all be individualised as they are traced towards this end of the section (Plate I. fig. 2 *a*). Any one examining it in this way can satisfy himself that the fibrillar appearance is only apparent, being produced by the close apposition of a number of the smaller fibres, whose outlines, seen all together, give the appearance in question. At the thin end of the section, where there is only one layer of fibres, there is no fibrillar appearance, and none of the fibres are striated longitudinally as Leydig describes them. Every stage of gradation can be traced between the dense longitudinal streaking and the unstriated fibres. This may account for Leydig's statement, that in the crab he has seen

* Hæckel gives the diameter of the fibres in the river crab as from $\frac{1}{166}$ to $\frac{1}{5000}$ of an inch. I measured them after they had been hardened in the chromic acid.

† Leydig, Lehrbuch der Histologie der Menschen und der Thiere.

‡ *Op. Citat.* p. 60.

fibres in an intermediate condition between the striated and the large tube-like ones. After the nerve-fibres of the lobster have been hardened in chromic acid, especially if they have lain long in the solution, they may be split up into fibrils by being tapped smartly between the cover and the slide (Plate I. fig. 2 *b*). Leydig says it is only the originally striated ones that can be broken up in this way; but any one may convince himself that all the nerve-fibres will split up in this way when hardened. The inter-ganglionic cords and peripheral nerves are entirely made up of tubes such as I have described, but in the optic nerves the fibres are much more delicate and smaller (Plate II. fig. 6 *a*), and the peduncles of the "hemispherical ganglia" seem to me to be composed of mere fibrillæ, and resemble much the fibrillation produced by breaking up the ordinary fibres. It is a curious and most interesting question, which I have not been able to solve, whether those minute filaments which we find in the cerebral ganglia do not, by their aggregation with similar filaments from other ganglionic centres in the brain, form the ordinary nerve-fibres. The latter would thus be compound structures, and might, at their peripheral terminations, again distribute their elements amongst the tissues. All the fibres contain oval nuclei scattered over them at regular distances. The nuclei bulge inwards towards the interior of the tubes. A few fresh nerve-fibres of the lobster, coloured with carmine, and then made transparent with acetic acid, form a very beautiful object under the microscope, from the nuclei taking up the colour. I have never been able to satisfy myself of the division of the nerve-fibres described by Hæckel.

When a nerve is cut across in such a thin section as to show the structure of the fibres, as in Plate I. fig. 4, they are seen to be tubular. This section also shows well the relative sizes of the tubes. The large ones at *a* appear as a series of open spaces, and it may be thought that they are merely the areola of cellular tissue left after the nerve fibres have been squeezed out in the manipulation; such, however, is not the case. From cross sections, in this way, too, it may be seen that there is no central solid band in any of the fibres. Cross sections of the fibres, as they leave nerve-cells, show in many cases gra-

nular contents, doubtless the granular contents of the cells prolonged into them. The appearance of a fibre as it leaves a cell, is frequently very different from that I have described and figured. It is smaller, and has not the same tubular aspect, and the nuclei are not present. It is very difficult to account for the existence of those large fibres, except by supposing that they are the result of the junction of smaller ones. The nerve-cells differ enormously in size; but as the fibres leave the cells, no such very marked difference in size is observable.

The Nerve-Cells.—Ehrenberg was the first to describe nerve-cells in the invertebrata, but he did not appreciate their importance. Since his time they have been particularly described in almost every division of the sub-kingdom, by Helmholtz, Hannover, Will, Kölliker, Wagner, Bidder, &c. Newport described them in the lobster; but so far from estimating their real value as the most essential parts of the nervous system, he thought they were for the nutrition of the fibres. It would be idle here to mention the disputes that have taken place as to whether the cells are apolar, bipolar, or multipolar. It is sufficient to say, that as micro-neurology has advanced, the belief has become strengthened and confirmed, that all the cells are at least unipolar, and most of them multipolar. Hæckel described and figured the nerve-cells of the river crayfish as large, nucleated, and either unipolar, bipolar, or tripolar.

If a portion of one of the ganglia of the lobster be torn asunder by needles and examined under the microscope, nerve-cells of various sizes will be seen, but they will all seem apolar. In the sections of hardened ganglia, however, they appear very different. They vary in form and character enormously. In size they range from $\frac{1}{50}$th to $\frac{1}{2000}$th of an inch in diameter.* They are filled with granular matter, which, as was mentioned before, is prolonged into the tubes they give off. After hardening in chromic acid this granular matter shrinks up round the nucleus, assuming a brown colour, more dense near the nucleus. The quantity of this granular matter in different cells varies much. In some, after hardening in chromic acid, the brown granular matter fills up

* In the river crab, Hæckel says they are from $\frac{1}{100}$ to $\frac{1}{500}$th of an inch in diameter.

the cell, whilst in others it is entirely absent, and the nucleus is uncovered. As a general rule, however, it fills at least half the space contained within the cell wall. It shrivels irregularly, and is connected to the cell wall by prolongations in all directions. This is so well marked in some cases, when the cell is large, and the nucleus is in the centre, that the granular mass seems a stellate cell giving off prolongations to a circle which surrounds it (Plate I. fig. 2 *d*). Those cells have generally more than one process given off from them as nerve-fibres. In many cases a large number of cells may all appear unipolar in one section, whilst if the section is made in a different direction they are seen to be multipolar. This is very well seen in the group of cells lying in front of the optic commissure in the cerebral ganglion (Plate II. fig. 4 *i*). The large nerve-cells generally give off larger processes than the smaller ones, but this rule is not invariable. It is a curious fact, however, that so far as one can judge, the number of large *cells* in the ganglia is in about the same *proportion* to the small ones, as that of the large *fibres* to the small ones in the inter-ganglionic cords.

All the cells are nucleated. The nuclei are always darker than the shrivelled granular contents of the cell, and correspond in size to the size of the cell. The varying quantity of the granular matter in the cells affords ground for curious speculation as to the causes why it should be so. May it not be that the cell's power or irritability is in proportion to the amount of its solid contents? They may in that way indicate the state of nutrition of the cell at the time the animal died; so that if this happened after the muscles of any part had been powerfully exerted for a long time, the cells in the nerve-centre supplying these muscles would be devoid of granular contents, and *vice versa*.

In addition to the connection of the nerve-cells to the fibres, they have also connections with each other, of which little or nothing has been said by any one (Plate I. fig. 2 *c*). Processes can be distinctly traced from one cell to another. Generally there is a stellate projection where such a process comes off from a cell.

There are other cells existing in large numbers in the cephalic ganglion at the roots of the cephalic nerves, which

are much more uniform in size and shape (see Plate I. fig. 3 *a*, and Plate II. fig. 6 *b*), being all small, round, and with stellate nuclei, which appear to send their processes to other cells, and to the roots of the nerves and to the hemispherical ganglia. Those cells are the smallest in the nervous system of the lobster, requiring a very high power of the microscope to discover their appearance. They are all about $\frac{1}{2000}$th of an inch in diameter.

In the cephalic ganglion also there are granular nuclei surrounded by a maze of minute fibres, which I shall afterwards describe more particularly. (Plate I. fig. 3 *b*).

The arrangement of the cells into groups is so constant that I must here make a few observations on the subject. It is not the result of natural boundaries, for two or more groups are constantly seen lying in contact, as in Plate II. fig. 1 *d*, *f*. The cells composing each group are of various sizes, and have more connections to each other than those of different groups, giving them a more intimate relationship than mere apposition. Each cell has generally one principal process, which runs in the same direction as the processes of the other cells of the same group; and this is what gives this grouping its importance and interest. The approximated processes of the cells form a kind of pedicle to the group, like the stalk of a bunch of grapes. All the processes of the cells of a group do not take the same course, but some of them may join the cells in another group (Plate I. fig. 6 *c*), or pass towards the cephalic ganglion. If the section is made in any other direction than that in which the pedicle goes, the cells may seem to be mostly apolar, or merely with processes to each other. I have frequently seen two bundles of nerve-fibres proceeding in different directions from what appeared to be but one group of cells.

Van der Kolk has described a similar arrangement in vertebrata.*

Before proceeding farther, it may be well to give a sketch of the anatomy of the nervous system in the lobster, as seen by the naked eye.† It consists of a series of ganglia, usually described as fourteen in number, but I think they ought to

* Van der Kolk on the Spinal Cord. Sydenham Society's Translation.

† I would here refer to a very correct representation of the nervous system of the lobster given by Newport in the Philosophical Transactions for 1834.

be stated as fifteen, the enlargement at the foot of the pneumogastric nerve (Plate II. fig. 3 *a*) being in structure and function like any of the other ganglia, as will be seen from its minute anatomy. One of these is cephalic; one æsophageal; seven thoracic; and six abdominal. The cephalic ganglion is supported by a strong fibrous membrane, attached to each side and behind it, and has a large fleshy mass nearly the size of the ganglion itself placed above it. Its form is oblong, flattened from above downwards, so that a section across it appears oval (Plate II. fig. 5). The two optic nerves are given off from the anterior angles, and the two cords from the first thoracic ganglion enter the upper surface at the opposite angles. From the sides and under surface four other pairs of nerves are given off to the antennæ, the organ of hearing, and the integuments about the head. The ganglion bulges into two prominences on the under surface behind the roots of the optic nerves, where it has also a more opaque appearance than elsewhere.

The two cords that connect the cephalic to the first thoracic ganglion are separated by the æsophagus which passes through between them. Each gives off a nerve to the æsophagus and stomach, which is sometimes divided into two (Plate II. fig. 3). There is always a ganglionic enlargement here, and a cross nerve connects the two cords after the æsophagus has passed through between them. These two enlargements, together with the cross cord, constitute, in my opinion, a true ganglion, as was conjectured by H. Milne-Edwards.*

The thoracic and abdominal ganglia have been carefully described by Newport.† His description, however, which is generally accepted, is biassed by his theory as to the existence of motor and sensory tracts. In the thoracic region, the longitudinal cords uniting the ganglia are double; in the abdomen, there is merely a single cord. Each thoracic ganglion consists of two little roundish masses of friable ganglionic substance, united by a ridge on the under surface. This ridge consists chiefly of transverse fibres from the lateral nerves of one side to those of the other. The nerves spring much more

* See Art. "Crustacea," in Todd's Cyclop. of Anat. and Phys.

† Philosophical Transactions, 1834, p. 408.

from the abdominal than the dorsal aspect of the ganglia. Newport was certainly mistaken when he described distinct abdominal and dorsal tracts in the cords. He even figures the division between them, and says they can be dissected* away from each other after the cords have been hardened. I have carefully examined the nervous system in more than a dozen lobsters, after hardening some in spirit and some in chromic acid, and I never could see any trace of those two tracts; and in thin cross sections of the cord and ganglia (as in Plate I. fig. 4) it is demonstrated that they do not exist. In the abdominal region, the inter-ganglionic cord is described as single; but cross sections reveal a septum prolonged from the sheath antero-posteriorly, dividing the cord into two not very symmetrical halves (Plate I. fig. 4). The septum bulges to one side, but the number of fibres on the one side is much the same as on the other. Where the septum joins the sheath on the upper surface, *d*, it is thickened, appearing as a triangular mass of fibrous matter. So distinct is this appearance, that I was at first disposed to consider it a tract of smaller nerve fibres. In the section represented, one of the posterior motor nerves, *e*, is seen cut across, as it lies in contact with the dorsal surface of the cord on one side. The fibres of those nerves are supposed to run upwards directly to the cephalic ganglion. The septum is present in each of the ganglia, but is not so distinct as in the cord.

The abdominal ganglia are slight elliptical swellings on the under surface of the cord. The lateral nerves in this region are very much smaller than in the thorax.

The anterior lateral nerves of the thoracic ganglion are much smaller than the posterior; and this is also the case, but not so much so, in the abdomen. Their distribution is thus described in "Todd's Cyclopædia:"† "The posterior and larger sends branches to the basilar articulations of the extremities; the anterior, again, distributes twigs to the muscles of the flanks; the two soon anastomose, and form a single trunk before penetrating into the extremity itself, which then traverses the whole limb, sending a branch to the muscles of each arti-

* Philosophical Transactions, 1834. Plate xvii. fig. 42.

† Vol. i. p. 765.

culation." The true distribution of those nerves is very easily made out by a simple experiment. I first performed it accidentally when dissecting out the nervous system in a lobster which was scarcely dead. As the anterior and smaller nerve of the large claw was being divided, the whole claw was strongly drawn towards the abdomen, and the nippers convulsively opened, while section of the posterior large one produced exactly the opposite effect,—viz., strong extension of the whole extremity, and convulsive closing of the nippers. This I have frequently since repeated, with the same result in both the large and small claws. The anterior is therefore the extensor, and the posterior the flexor nerve of the claw. The size of the nerves is seen to be in exact proportion to the force of opening and closing the pincers in the large claws, and in the others the two nerves are much more uniform in size.

The first thoracic ganglion gives off ten pairs of nerves to the mandibles and foot-jaws. The caudal ganglion is triangular in form, with a large bulging on the under surface. It gives off ten nerves—two to each of the five segments of the tail, one for the outward, and the other for the inward motion. This may easily be demonstrated by experiment.

Microscopic Anatomy.—The minute structure of one of these ganglia can only be studied by making thin sections through it in different directions, to show, 1*st*, The distribution of the ganglionic matter; 2*d*, The course of the fibres given off by the nerve-cells; and 3*d*, The course of the fibres of the peripheral nerves when they enter the ganglia. The second is the most difficult part of the investigation. I selected about fifty from the sections I made and put up permanently as microscopic preparations; and after a careful examination of these, I have drawn the accompanying plan (Plate I. fig. 7), which embodies in one view all the facts observed in reference to the cells and fibres in a ganglion. Many of the sections merely show the distribution of a single group of cells; but it seemed to me that no clear or truthful idea of a ganglion could be got except by arranging together, in an ideal ganglion, all the isolated facts observed. The interlacement of fibres is such, that it requires many sections to be made across, and longitudinally, and in an oblique direction, to demonstrate all the anatomy.

A ganglion in the thoracic region is the most typical, being bilateral, and one of those I shall therefore describe first. There are a number of fibres which enter into and pass out of each ganglion without being connected to cells at all. These have been well described by Newport, and I merely had the opportunity of confirming the accuracy of his observations. He describes four sets of fibres :—1. Those which arise in the cephalic ganglion, and pass downwards on the dorsal surface of the cords, not entering farther into the formation of each ganglion (Plate I. fig. 7 *a*). 2. Those which are given off from the longitudinal cord, and enter into the formation of the lateral nerves directly *c*. These fibres bend round, and emerge from the ganglion at a right angle to their entrance. 3. Those which pass transversely across the ganglion from one lateral nerve to the one of the opposite side, and at right angles to the first set of fibres *b*. At least one half, or, in some of the nerves, (*e. g.* those in third thoracic ganglion), two-thirds of the fibres pass across in this way. They bend round the longitudinal cord on the under surface, only a few of them interlacing with the longitudinal fibres. Their curvature in this direction renders it impossible to make sections in the longitudinal direction, showing the fibres running from one side to the other. If the section is made in the course of the fibres of the lateral nerve of one side, they are cut across in the middle line. Cross sections of the ganglia through the roots of the nerves are not much more successful, as the nerves have a very slight direction forwards, so that they meet at an angle in the middle line in this direction as in the other. A few cross fibres may often be seen in this way, however. 4. The remaining set of fibres, like the last, have no connection with the head. They cannot be traced in the lobster from one ganglion to another. Newport describes them in the Myriapoda, where the ganglia are closer together, and indistinct bands of fibres can be traced from the one to the other. They seem in each ganglion to be part of the second set of fibres, but instead of going to the head, they run a certain distance along the cords, and then join the lateral nerves of other ganglia on the same side of the body. In some sections a band of fibres is seen to bend outwards and join the lateral nerves,

corresponding to those at *e* in the diagram. Those evidently connect the parts of the body posterior to this ganglion, with the segment of the body which it supplies. It is probable that these are both fibres of reinforcement, and comprise also fibres from the cells of the ganglia, posterior to the one from which this section was made (those at *f* in Plate I. fig. 5). Some of them run from one ganglion to the next, whilst others extend to ganglia farther away, thus keeping up a direct connection between all the lateral nerves of the same side. I have myself demonstrated the existence of such fibres in the leech, connecting the two lateral nerves of the same side in the same ganglion. In that animal, some of the fibres of one lateral nerve bend round, and, without entering farther into the composition of the ganglion, emerge among the fibres of the adjacent nerve. Newport calls them "fibres of reinforcement," because they keep up the bulk of the longitudinal cord to the last ganglion.

The ganglionic matter is disposed in five places in each ganglion,—viz., in the four angles formed by the lateral nerves and longitudinal cords, and in the space between the two longitudinal cords. Those aggregations of ganglionic matter are not really distinct from each other, for that in each angle is connected with that in the other angle of the same side by a bridge, that passes round the entering lateral nerve, encircling it in a collar. It is this that partly forms the bulging on the under surface, that gives the character to the ganglion.

When a longitudinal section is made in the course of the nerve-roots as they enter the ganglion, and if the section be near the abdominal surface, the following appearance presents itself (Plate I. fig. 5). The longitudinal and transverse fibres are seen crossing each other, *c*, and a bundle of nerve-fibres from the lateral nerve are seen to change their course, and become continuous with the longitudinal cords, *d*. In many of the sections I made, this is seen much more distinctly than in the one represented. In the angle of meeting of the lateral nerve and cord, the nerve-cells are seen; and in this case they lie in two groups *f* and *g*. The cells of each group seem to be, for the most part, unipolar, but this results from many of them being superposed. They are of very different sizes, two very large ones being seen at *h* and *i*, but most of the

others are small. In all of them, the granular contents are condensed round the nucleus by the chromic acid used in hardening the specimen. Each cell gives off one principal fibre, and all the fibres of the cells of each group collect together into a bundle. The main group sends its fibres to become continuous with the fibres of the longitudinal cord. These correspond to the group at *f* in Plate I. fig. 7. In this section, many of the fibres from the cells thus seem to join the longitudinal cords; but in by far the majority of the sections I made, the fibres from the principal groups of cells join the lateral nerves. The largest cell *i*, in the other group, has two processes going from it in the same direction,—viz., to the lateral nerves of the opposite side, and corresponds to those at *g*, in the diagram. This section also shows a few of the cells in the centre of the ganglion, between the two longitudinal cords, *k*, whose processes evidently go in an oblique direction to the other lateral nerve of the same side. They are a few of the cells seen in Plate II. fig. 1. On the other side of the nerve at *l*, between it and its fellow of the same side, there are a number of detached cells belonging to the ganglionic collar which invests each lateral nerve as it joins the ganglion. Most of these processes pass towards the opposite side, but many of the cells are seen to be bipolar, each pole taking a different direction. They correspond to a part of those at *i* in the ideal section. Of the other processes of the cells, some pass into the lateral nerve of the same side, and others upwards among the longitudinal fibres. The cut fibres at *m* are a bundle of longitudinal ones cut across as they pass over those of the lateral nerves.

If we now examine a section made in the same direction, somewhat more towards the dorsal part of the ganglion, as is represented in Plate I. fig. 6, a somewhat different appearance is presented. That at fig. 6 is a section of the same ganglion as that at fig. 5. In it the longitudinal fibres are cut somewhat obliquely. In fig. 6 *a*, many of the cells are seen to be connected with each other by processes; and not only are those of the same group connected in this way, but also those of the two groups seen at *c* and *d*. The cells next the longitudinal cord, *c*, send the greater portion of their fibres at first trans-

versely, but they soon change their direction, and reinforce the longitudinal cord. This group corresponds to that at *k* in fig. 7. In this section those fibres cannot be traced, so far as to show that they do not change their course and join the lateral nerves, but I have other sections which demonstrate this point. The fibres from the other group, *d*, join the lateral nerve of the opposite side. They are not so distinctly seen as those from group *c*, for they are on a lower level, and covered by the longitudinal fibres. They correspond to *g* in fig. 7, and are representative of a larger number of fibres in the ganglia than any other group. This can only be ascertained by examining a large number of sections; and after doing so, and ascertaining the comparative frequency of the groups represented in fig. 7, I find that those at *g* and *k* are by far the most frequently met with, thus establishing the tendency of groups of cells in the ganglia to send most of their fibres to the opposite side. The groups of cells which send their fibres to the lateral nerve being more numerous than those which send them to the longitudinal cord, it follows that the group at *g* is representative of a larger number of nerve-cells in the ganglia than any of the others. In connection with the group at *c*, fig. 6, there are a few fibres, whose processes, *f*, pass in an altogether opposite direction to the main body of the fibres of the group, and are represented by the upward fibre seen at *g*, in fig. 7.

I selected those two sections, not because they present the most typical cells, for their cells seem many of them unipolar, and with fewer than ordinary observable connections to each other, but because they are of the same ganglion, and show the principal bundles of fibres from the groups of cells running in a great many different directions, illustrating, more or less fully, nearly all the ideal section in fig. 7. A section in my possession shows, in addition to the fibres of reinforcement, two groups of cells, whose processes pass to the lateral nerve of the opposite side, and backwards to join the cord. The latter are represented in Plate I. fig. 6 *c*.

The ganglionic substance, situated between the two cords, is best seen in cross sections of the ganglia through the roots of the nerves, like that represented in Plate II. fig. 1. The space

between the cords, especially towards the abdominal aspect, we then see to be filled up by cells, which arrange themselves into four principal groups, two on each side of the middle line. Those groups are indicated in the section, more from the bundles of fibres proceeding from them, than anything else. At *d* we see a group of pretty uniform cells, sending its chief bundle of fibres across the middle line to join the lateral nerve of the opposite side. It corresponds to the group at *m* in Plate I. fig. 7. At *f* there are a number of large cells, most of which send their processes to the lateral nerve of the same side. The nerve processes from opposite sides (*e* and *d*) cross in the middle line. Those at *f* correspond to the fibres at *h* in Plate I. fig. 7. The groups of cells situated nearest the middle line are thus seen to send their processes to join the lateral nerves of the same side, while those situated more externally send theirs to the lateral nerves of the opposite side. The group at *g* is one whose pedicle has been cut off, and the cells appear apolar. In another cross section in my possession, a crossing of the fibres at the root of the nerve is seen, some of those lying above, passing downwards to the abdominal surface of the nerve, and *vice versa*. The object of this is not apparent.

The structure of an abdominal ganglion is very much the same as I have described. The ganglionic substance is less in quantity, and forms an oval bulging on the abdominal surface of the cord. The separate aggregations of ganglionic substance which I have described in the thoracic region are here fused into one, the cells situated between the cords being pushed downwards by their union. There are more cells anterior to the lateral nerves than posterior to them. The grouping of the cells is still seen. The arrangement is best seen in a longitudinal section made from the dorsal to the abdominal surface. Such a section is represented in Plate II. fig. 2. Numerous groups of cells are seen whose processes all run towards the dorsal surfaces. The most anterior group, and the one next it, *c*, send their processes far up among the longitudinal fibres, and at *d* they may be seen to change their course and join the longitudinal fibres towards the cephalic ganglion. The processes of the next group, *e*, run towards the fibres of the lateral nerves, seen cut across at *b*, some of them

apparently joining them, whilst others run upwards among the longitudinal fibres. All the other cells *f*, send their processes towards the lateral nerves, showing a tendency to encircle them, so that we can have little doubt they reinforce them. By far the larger number of fibres from the cells in this way cannot be traced any further than the lateral nerves. A cross section of an abdominal ganglion opposite a nerve displays three principal aggregations of cells; one on either side, and one in the middle. The mediate septum is more distinct than in the thoracic ganglia. The middle group of these cells correspond to those between the cords in the thorax (Plate II. fig. 1). Some of the fibres from the two outer groups of cells pass into the lateral nerves of the same side, whilst others cross to those of the opposite side. The fibres from the middle group run upwards along the septum at first, some of them going to the same side, and others to the opposite side. Many of the cells of the latter group show processes cut across which take a different direction from the main body of the fibres, and which probably give them a connection to the longitudinal cord.

Some comparative anatomists, such as Newport and Bruch, have described ganglionic cells in the roots of the lateral nerves in the invertebrata analogous to the ganglia on the posterior spinal nerves. Bruch figures them in the leech.* I have made the most careful sections of the roots of many of the thoracic nerves, and have not been able to detect their presence in the lobster. Indeed, I am satisfied that they do not exist, for I sliced the roots of several of the nerves in the longitudinal direction, and examined all the sections under the microscope without being able to discover a single cell. In some cases, the collar of ganglionic substance, which I have described as encircling the lateral nerves as they join the ganglia, extends a little outwards, but this is in no degree analogous to a ganglion.

The Pneumogastric Ganglion.—The slight swelling at the root of each pneumogastric nerve (Plate II. fig. 3), is found on examination to consist of ganglionic matter. When a thin longitudinal section is made of it, groups of cells are seen to

* Even in the leech I have not been able to confirm Bruch's observation.

surround the roots of the nerve, whose processes pass, some of them upwards along the cord towards the cephalic ganglion, some of them along the nerve, but the greater number of them downwards towards the first thoracic ganglion. If we dissect off the fibrous covering from one of the cords, and also from a small portion of the cross nerve (Plate II. fig. 3 *c*), and trace its fibres under a microscope of low power, they may be seen to run as a distinct bundle, and aid in the ganglionic swelling (*a*). Many of them pass directly into the pneumogastric. Each cord is thicker at the part between the cross nerve and the root of the pneumogastric than at any other place. Those two swellings, therefore, are the two halves of a ganglion, and the cross cord is the commissural fibres. It is a ganglion dissected by Nature to let the æsophagus pass through between the two longitudinal cords at that part. This view is taken by H. Milne-Edwards in the article "Crustacea," in Todd's Cyclop. of Anat. and Phys., but I am not aware that he had any grounds for this opinion from dissection.

The Cephalic Ganglion.—Like the other ganglia of the body, the structure of this can only be ascertained by making sections through it at different parts and in different directions. A thin longitudinal section of the whole ganglion near its upper surface, and through the longitudinal cords at their junction, and the roots of the optic nerves, presents the appearance seen in Plate II. fig. 4. But before describing this, it may be well to describe a thin section of the roots of the longitudinal cords alone. The fibres from each spread themselves out; a number of the inner ones passing across the middle line, and forming a true decussation with those of the opposite side. Some of the fibres of each that lie most external, cross over the inner fibres, and become continuous with corresponding fibres from the other cord (Plate II. fig. 4 *k*.) In this way there is as direct a communication between the two longitudinal cords of the body as between the lateral nerves of opposite sides of a ganglion. The same section includes a part of the roots of the second cephalic nerve, a bundle of the fibres of which turns downwards and joins with the fibres of the longitudinal cord of the same side. Scattered amongst these fibres, there may be seen a few groups of ganglionic cells with no appa-

rent connection to the fibres; but this probably results from the way the section is made. The majority of the fibres of the longitudinal cord do not decussate.

If we now examine the section to which I have referred, which is made in the same direction as the last, but deeper, we see the arrangement of the deeper fibres of the longitudinal cords and of the optic nerves (Plate II. fig. 4). Most of the decussating fibres of the cords become continuous with the roots of the optic nerves of the opposite side *c*. A number of the fibres, which do not cross, are also seen to reinforce the optics *d*. Passing from one optic nerve to the other, there is a large bundle of fibres forming a commissure *e*, as in the vertebrata. Indeed, it will be seen that the roots of the optics take the same course as in the vertebrata. There are commissural fibres, fibres crossing to the other side of the middle line, and fibres remaining on the same side.

In the middle of the thoracic cords there is an oval space *f*, where the fibres are cut across. This is not seen in a more superficial section, and is a large bundle of fibres that join the cords at this part from the large ganglionic mass to be presently described. They join the fibres of the cords at an acute angle, and are bending down to take the direction of the latter, where they are cut across in this section. At three points ganglionic cells are seen *i*, *h*, and *g*. They are all towards the periphery of the ganglion, and the processes from the cells take an inward direction. The largest group fills up the crescentic space in front of the optic commissure. These processes seem all to pass backwards, crossing the commissural fibres in bundles. In a section in which they can be traced, they are seen to join the longitudinal cords of the same side. The cells seem to be all unipolar in this section, but in a vertical one it is seen that there are other processes from the same cells which take a different direction, passing downwards on the under surface of the ganglion towards the roots of the cephalic nerves. The two other groups of cells in this section are packed as it were into the triangular space formed by the meeting of the optic nerves and longitudinal cords with the fibrous sheath to the outside. These fibres go downwards and backwards to reinforce the cords also.

A section still deeper, in the same direction, brings into view a part of the granular masses to which I have referred, exterior to the cells at *g*, in Plate II. fig. 4.

The structure of the deeper parts of the ganglion is best shown by cross and vertical sections through it. But in order to dispose of the anatomy of the optic nerve, I shall first describe a section diagonally through the ganglion (Plate II. fig. 6). This displays the course of the deep fibres of the optic nerves, which are seen to radiate on entering the ganglion, the upper ones passing over the hemispherical ganglia *e*, and following the course I have already pointed out; the deeper ones passing out first backwards, and then being reflected at an acute angle over the granular masses, leaving a space *b*, which is filled up with cells of the kind figured in Plate I. fig. 3 *a*. Many of the fibres of the optic nerve seem to lose themselves amongst those cells, some of them evidently being connected with them.

A cross section of the whole ganglion, near the centre, or slightly anterior to it, shows well its anatomy. Such a section is represented in Plate II. fig. 5. Only at one part can such a view be obtained, the slightest variation to either end of the ganglion obscuring its most important points. The ganglion is seen to be bilateral. On either side, and situated somewhat more towards the upper than the lower surface, are two large granular bodies *a*, of a somewhat circular form, well defined all round, except inferiorly, where a large bundle of fibres, which we may call the "peduncle," emerges. Each mass has apparently little connection with the surrounding parts, except by means of this peduncle. Externally it comes in contact with the fibrous sheath of the ganglion, and internally it is in contact with the longitudinal cord, seen cut across at *c*. Each has seven or eight concentric rows of nuclei imbedded in it. The periphery, in which are the two outer rows of nuclei, is less densely granular than the interior, and the nuclei are less distinct. Towards the centre the granular matter assumes a fibrillar appearance, the striæ being in the direction of the peduncle; and they gradually, when traced further, assume the fibrous form, as seen in the peduncles. The peduncle is narrower at the part where it leaves the mass than

at any other part of its course. It passes at first downwards, then turns sharply at a right angle inwards, and finally bends to join the longitudinal cord of the same side. In one section in my possession, a few cross-fibres may be seen, as if they connected the two peduncles together.* Such is the appearance presented by a section of these structures, which I shall call the "Hemispherical Ganglia," when examined by a power of seventy-five diameters. Their general form can only be seen by sections in other ways as well. They are egg-shaped in a section of the ganglion antero-posteriorly, the long diameter running from before backwards. With their peduncles they form between a half and a third of the whole cephalic ganglion. In a cross section they do not seem so large, but their true size appears in a longitudinal section. Each has a hilus, from which the peduncle emerges. If a section be made above or below this hilus, the concentric circles of nuclei are complete, and there is a whorl of converging fibres in the centre. The slight connection each hemispherical ganglion has to the surrounding parts is well seen in the great difficulty of preserving it from being detached in very thin sections, that do not include the peduncle. In a very well hardened cephalic ganglion, the two oval masses may be dissected out.

Again to refer to the section—immediately behind each hemispherical ganglion, there is an irregularly elliptical mass of granular matter *d*, with lighter striations from behind forwards. These striations, when examined with a higher power, are seen to be fibrous. They appear to reinforce the peduncles of the hemispherical ganglia below; for as succes-

* Since the above was first written, Professor Goodsir, to whom I am under great obligations for his kindness in revising this paper, has pointed out to me, that M. F. Dujardin (Annales des Sciences Naturelles, 3d serie, tome xiv.), has described the external appearance of similar structures in the bee. In that animal they are quite distinct, with their peduncles, without any dissection of the cephalic ganglion. In fact, the cephalic ganglion of the bee would closely resemble that of the lobster, if, in the latter animal, those structures were cleared of their surrounding tissue, and left hanging by their peduncles. Dujardin calls them in the bee "les corps pédonculés," which in their interior present "une disposition stratifiée." He endeavours to make out, that in insects the bulk of the *corps pédonculés* is in proportion to the intelligence of the animals.

sive sections are made from above downwards, the fibrous matter increases in quantity, until at the very lowest part there is merely an aggregation of fibres, twisting about in a very inexplicable manner.* In the spaces included by the ganglia and their peduncles *e*, there is a group of those cells seen in Plate I. fig. 3 *a*. Most of their processes appear to pass upwards, and are lost where the hemispherical ganglion comes in contact with the longitudinal cord. This is the group of cells in which a part of the fibres of the second cephalic nerve ends, as is shown in a section I made through the root of this nerve. In the middle line there is a large group of ordinary ganglionic cells, such as are seen in the other ganglia *f*. They send most of their processes upwards, a few of them joining the opposite cord, but most of them going to that of the same side. On each side of this group, and below the peduncles, there is another aggregation of cells similar to those at the root of the optic and second cephalic nerves *g*. These processes chiefly pass outwards, and they doubtless form a nucleus for the roots of some of the other cephalic nerves.

The only other part of the ganglion undescribed is the posterior and under part, into which the other cephalic nerves enter. On account of the different directions of these fibres, it is very difficult to trace each to its termination. All the nerves send a part of their fibres to join the longitudinal cords directly, and another part to enter into the groups of ganglionic cells which abound there. Most of these cells are of the same kind as those in the thoracic and abdominal ganglia.

The minute structure of the hemispherical ganglia can only be seen in very thin sections and with a very high power. If they have been coloured with carmine, it is still better seen. The matter, which appears granular when viewed with a power of 70 diameters, is seen to be only partly granular when viewed with a power of 600 diameters. It is then seen to be chiefly composed of small fibres, very tortuous, bending and twisting at acute angles, and in all directions, amongst each other, each fibre being only capable of being followed for a very short

* I may mention, that in the cephalic ganglion of the crab (*Cancer Pagurus*) the structure of the hemispherical ganglia is the same as that of the masses here described.

distance. It is more like what we might suppose a fishing-net crushed up to be, than anything else to which I can compare it. Among those extremely minute fibres there are a number of granules scattered. The nuclei-like bodies that lie in concentric rows, are not really nuclei, or rather they are more than nuclei, for the greater part of each of them is composed of those fibres I have just described, packed more closely than in the surrounding tissue. In the centre of each there is a nucleus like that of an ordinary nerve-cell, only a little more irregular in its outline (Plate I. fig. 3 *b*). This can only be seen in the thinnest section, for it is surrounded by a dense brush-like areolus of the small fibres which seem to be implanted on the nucleus—growing from it, as it were, and giving it its irregular outline. Each nucleus has either one or two nucleoli. In a very thin section, also, there is seen round each of those bodies a lighter areolus, where the fibres and granules are not so densely packed (Plate I. fig. 3 *b*). It is curious to trace the origin of the fibres of which the peduncle is composed. A little striation is at first seen, the tortuosity of the fibres diminishing gradually till they become straight, and lie parallel to each other. The granules which are scattered among the fibres, when examined by a power of 900 diameters, seem to be, many of them, thickenings of the fibres, and others the centres from which two or three small fibres proceed in a stellate manner. The fibrillæ, of which the peduncle is at first composed, very much resemble the appearance of the large fibres after they have been split up by concussion. The large fibres of the nerves and longitudinal cords would therefore seem to be composed of these minute fibrillæ which arrange themselves so as to form tubes very much as a cask is made up of staves. In the perfectly formed tubes of the peripheral nerves, no trace of striation is to be seen in a cross or longitudinal section, even when examined by a power of 900 diameters. I think it is very probable, however, that at their peripheral extremities where they come into intimate relationship with the tissues to which they convey the nerve-force, that they may again split up.*

* In the crab, the minute anatomy of the cephalic ganglion is very similar

Lying in contact with the outside of the hemispherical ganglia, there is a kind of fibrous covering very like a vascular coat. The fibres composing it are larger, and interspersed among them are small arteries, sending branches at regular intervals into the ganglia (Plate II. fig. 6). Along with the arteries and fibres there are also many caudate and stellate ganglion cells, whose fibres interlace and enter the ganglion. At certain parts, groups of cells like those seen at Plate I. fig. 3 *a*, lie in contact with the hemispherical ganglia, and give off processes into them.*

I cannot help thinking that the "punctiform mass" described by Leydig† as occurring in the Arthropoda and in spiders, and by Leuchart in the Acalepha, must be of the same nature as the hemispherical ganglia I have just described. In those animals, the ganglia are so small, that sections of them cannot be made, and without this, their true anatomy cannot be ascertained. The idea put forward by Leydig, that the granular matter is for the support and preservation from injury of the delicate cells, is not consistent with what is observed in the nervous system of any other class of animals, whose nerve-cells are as delicate, and require protection quite as much as do those of the animals to which he refers. Leydig, indeed, mentions somewhat vaguely, that "there are often forms of such a nature, that clear nuclei, with nucleoli, are surrounded by part of the punctiform substance, merely in the form of an areola, and perhaps no essential distinction can be made between such extra cellular punctiform substance and that enclosed within the ganglionic bodies, since in many animals, no ganglionic bodies are present, but the homogeneous punctiform substance fills up equally the ramifications of the nervous tubes."

Physiological Inferences from the foregoing Data.—The physiology of the nervous system of the invertebrata was

The nuclei are not distributed in concentric rows, and striation, like that seen where the peduncle takes its origin, is more general.

* In the crab, this investment is much better seen. Distinct bundles of fibres run inwards from it to join the fibres of the peduncle without being in any way connected with the nuclei. The cells that surround the hemispherical ganglia in this animal are both of the large and small kinds.

† *Op. cit.*, p. 69.

greatly advanced by means of experiments on the living animals, before much of its anatomy was known. Valentin seems to have been the first to perform a series of experiments, and he selected the *Astacus fluviatilis*, a species closely allied to the subject of the present paper. He came to many correct conclusions on the subject.* He shows a decided tendency to compare the abdominal ganglia in this animal to the sympathetic ganglia of the vertebrata, and he had not the theory of reflex action to explain many of his difficulties. It is unnecessary for me to detail fully his experiments, nor those of Mr Newport, performed on the Iulus. I have repeated those of Valentin on the lobster, with the same results as he obtained. I have also performed one or two others, viz., cutting one of the cords connecting the cephalic to the first thoracic ganglion, and then observing whether a stimulus to that side of the head on which the section was made, was followed by reflex action on both sides of the body. I found that the animal, after such a mutilation, although it had lost all voluntary power over the muscles of the extremities of that side, yet displayed reflex action on both sides alike, in response to impressions made on the eye or antennæ of the injured side. This is important, as indicating cross action, both in the brain, in order that the impression should pass down the uncut cord—and in the ganglia, to produce motion on both sides of the body.

The influence of the cephalic ganglion is at once explained by the cords that proceed from it to distribute their fibres to the lateral nerves that supply every part of the body. The bulk of the longitudinal cord is well kept up to the caudal ganglion, and this can only be explained by the existence of the "fibres of reinforcement" of Newport, or fibres from one ganglion to another, and going no further. The former connect one part of the periphery with another on the same side of the body, joining the cord by the lateral nerves of one ganglion, passing either upwards or downwards, reinforcing the cord at that part, and then passing away as part of the nerves of the next ganglion, or those of a more distant one. According to no recognised law of nervous conduction can these

* Valentin, "De Functionibus Nervorum," p. 8.

fibres receive any influence from the centres through which they merely pass, and they can only serve to connect different parts of the body by means of that nervous apparatus which all recent investigations prove to exist at the periphery. Why the nervous filaments should take such a course to connect parts so near as the segments supplied by contiguous ganglia, and not go directly from one to the other, I cannot pretend to explain, except it be taken as an explanation that they do so for greater protection from injury, or, it may be, in consequence of the mode of development of the nervous system.

The next question that arises about these and similar fibres is, whether they have anything to do directly with reflex action; in other words, whether they originate as excitor and terminate as motor nerves. It would be contrary to all that we know of the laws of reflex action to suppose that they do; for wherever in the animal body we have reflex action, we have ganglionic matter in the central parts of the nervous system that supply the parts. But although not directly ministering to reflex action, they seem to be in some way connected with it, for they exist in much larger numbers where reflex action is best seen. Where muscular action is complex, and there are many small muscles acting in different directions, those fibres abound most. Their number seems in fact to have some relation to the complexity of action.

An examination of the absolute amount of nervous matter, both fibres and cells, in different regions, and a comparison of this with the number and size of the muscles which are supplied, throws much light on this and other questions connected with reflex action. In the thoracic region, the muscles are small, but numerous. There are fourteen legs, besides foot-jaws and mandibles, each leg having seven joints bending in opposite directions, requiring of course a flexor and extensor muscle at each joint. There are 196 independent muscles, therefore, connected with the legs alone, and we find that it is in the thoracic region that the ganglia are very large, and the longitudinal fibres numerous, as shown by the thickness of the two cords, and the fibres running from one side of the body to the other are numerous also, as shown by the large nerves, at least one-half of which pass

from one side to the other across the ganglia. In the abdominal region, on the contrary, the ganglia are small, and the longitudinal cord not the size of one of its divisions in the thorax. The muscles, however, are at least six times as bulky; the whole space included within the rings of the abdomen being filled with an immense mass of muscular structure for the propulsion of the animal through the water. This muscular mass is very differently arranged from the 196 separately-acting muscles of the thorax. It forms large single muscles, whose fibres act in concert, except the slender extensor fibres. If we now compare one leg with another, where the conditions are similar as to the number of joints, but different as to the mass of muscular structure, we find the same rule exemplified. The larger claws contain bulky and enormously strong muscles, the smaller ones very slender and weak muscles, while the absolute number is the same in both; but we do not find the size of the third thoracic ganglion that supplies the large claws at all in proportion to the bulk of the muscles. It is certainly larger than the other thoracic ganglia, but its bulk is principally made up on the abdominal surface by the large lateral nerves, a great part of which cross from one side to the other. The ganglionic matter in it is not much more than in the others. The first and second thoracic ganglia too, which supply ten small nerves on each side to the foot-jaws, and mandibles, contain more ganglionic matter than any of the other ganglia, except the cephalic, yet the *mass* of muscle supplied by them is very small, while the *number* of muscles is large. The caudal ganglion too contains much ganglionic substance,—much more than any of the abdominal ganglia,—while the muscles it has to supply are small but numerous. What conclusions can be drawn from these facts?

1. The ganglionic matter subserves the purpose of reflex action, and is essential to it.

This is beautifully shown by Professor Owen, by a comparison of the abdominal nervous cord of the hermit crab with that of the lobster.* In the one animal, there are no muscles in that region, but only viscera, and a large surface of very sen-

* Owen's Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals, vol. i. p. 171.

sitive skin; in the other, the muscles are strongly developed; in the former, there are no ganglia, but merely a nervous cord, to transmit impressions upwards; in the latter, there are large ganglia.

2. The so-called "fibres of reinforcement," and the fibres that cross from the lateral nerves of one side to those of the other, without being connected to ganglionic cells,—all those fibres, in fine, which directly connect different parts of the periphery, whether on the same or on opposite sides,—are muscular at both extremities,* and are not the channels through which reflex movements take place, but they serve to *connect, harmonize, and render consentaneous* the action of muscles otherwise independent, on the same and on opposite sides of the body. Where the number of muscles is great, both these kinds of fibres are numerous; and they also have some relation to the size of the muscles, as we see the number of cross fibres much larger in the third thoracic ganglion than in any of the others.

3. The number of the ganglionic cells is in direct proportion to the number of the muscles and the complexity of movement, and not to the mass of muscular structure.

4. The action of those muscles which always move simultaneously, and for a definite end, is combined and regulated by the ganglionic cells (in which the muscular nerve-fibres terminate) arranging themselves in groups,—each group ministering to a limited number of muscles.

Thus the "fibres of reinforcement" and the cross fibres are supplementary to the groups of ganglionic cells in the perfect production of reflex movement, and, by their conjoined action, give that harmony of muscular action and adaptation to definite ends which is one of the most wonderful of all the wondrous provisions of existence in the animal body.

5. Each of those groups of cells has a connection to the cephalic ganglion, and to the neighbouring groups.

6. The groups of cells send their fibres to the same side of the ganglion in which they lie, but chiefly to the opposite side, and to the muscles of the opposite side.

The fibres from the groups at *f*, *k*, and *i*, in Plate I. fig. 7,

* The commissural fibres of the optic must be excepted.

are those to which I refer. We cannot suppose that those at *f* and *k* all go to join the cephalic and caudal ganglia, and they must therefore join the lateral nerves of other ganglia above and below. The groups of cells like those at *i* which send their fibres to the lateral nerves of the opposite side, while they also have a connection with the longitudinal cord of the same side, are equivalent to a crossing of the longitudinal cords, so far as reflex movements are concerned, and explain the production of reflex movements on both sides of the body after one longitudinal cord had been divided, the stimulus having been applied to the head. In each of those ganglia we have a mechanism quite sufficient to account for its independent action so far as its own segment of the body is concerned, and its co-operation with, and relation to the other ganglia, in producing, regulating, and combining the motions of the hundreds of muscles on the same and opposite sides of the body.

The third, fourth, and fifth conclusions are those to which Schrœder Van der Kolk comes in regard to the arrangement of the cells in the vertebrata.* Doubtless, as further advances are made in our knowledge of the far more complicated structure of the spinal cord of mammalia, the other conclusions will be proved by demonstrative evidence also to apply. In this lies the peculiar value of careful investigations into the arrangement of the cells and fibres in animals of a lower class where they are not so much concentrated and crushed up, as it were, that they pave the way for the discovery of similar facts in the higher class. Although the "fibres of reinforcement" and cross fibres cannot be demonstrated in the spinal cord, yet there can be little doubt that they exist, and have the same relation to the cells and their processes, as well as the same function, as in the *Astacus marinus*.

From the structure I have already demonstrated, we may infer that the cephalic ganglion corresponds to the brain of the vertebrate animal. That its functions are analogous has been abundantly proved by Valentin and Newport, and confirmed by my own repetitions of their experiments. When we endeavour to ascertain the corresponding parts in the brain of a lobster and a fish, considerable difficulties present them-

* Van der Kolk on the "Spinal Cord," Syden. Soc. Trans., p. 73.

selves. The structures which I have called the "hemispherical ganglia," with their concentric rows of nuclei and slight connection with the other parts of the ganglion, are so very unlike anything that we see in the brains of mammalia, that we are puzzled to discover their homologues. Nor does their relation to the roots of the cephalic nerves, or the origin of the interganglionic cord, appear at first to explain their nature. Fibres pass into them from the groups of ganglionic cells at the roots of the various cephalic nerves; some of the fibres from those nerves may pass into them directly, but this I was never able to demonstrate; and by means of their peduncles joining the longitudinal cords, they have a direct connection with all the other ganglia. They would therefore seem to have a function different from the ordinary nerve-cells—a general and diffused function, which has no special relation to any part of the animal, or to any of its sensory or motor apparatus, but is supplementary to, and conjoined with, the action of those cells, wherever innervation exists in the body. It is no unjustifiable inference to suppose, that in them reside the higher manifestations of nerve-force which the animal exhibits. The lobster is not a mere machine, that responds to impressions made on its nervous system from without through its organs of special senses, or on the extremities of its afferent nerves The actions which it performs as the result of these may be explained by means of the arrangement of cells which we have seen in the ganglia, and at the roots of the cephalic nerves; but we cannot so account for its great cunning and perseverance in the search for food, its sexual appetites and instincts, its regular migratory habits from deep to shallow water at certain seasons, its strongly developed instinct of self-preservation, &c. These approaches to psychical manifestations doubtless require special nerve-tissue for their exhibition; just as we know that in the higher animals the psychical functions are connected with the cerebral hemispheres; and the only part of the nervous system in the lobster containing nerve-cells, to which no other function can be assigned, are these hemispherical ganglia. We therefore conclude, that in them originate those manifestations of a higher animal life.

The terminations of the nerves of special sense in the

cephalic ganglion of this animal are extremely interesting. Some of the fibres end in cells precisely similar to those of the thoracic and abdominal ganglia. And not only are the cells the same in size and appearance, but they are distributed into groups in the same way. Their other fibres run to form part of the interganglionic cord directly. The mechanism of nerve cells for special sensation is therefore, so far as we can ascertain it, the same as for general sensibility through the body. Of course there must be a difference in the mode of activity of those cells, the nature of which will probably for ever remain inappreciable by us; but we thus see that impressions made on the special senses are followed by muscular movements, just in the same excito-motor way as impressions on any other part of the body. The muscles of a lobster's large claw may be thrown into action, either when this claw is touched, or when a foreign body is seen; in the one case the impression being transmitted upwards by the afferent nerve-fibres of the organ to the groups of cells which control its muscles; and in the other case, the impression being transmitted along the optic fibres, which we have seen to join directly the interganglionic cord, to the same groups of nerve cells, and with the same result,—viz., to cause a combined muscular movement by the nerve-force originated in those cells, and transmitted along the efferent fibres. In both cases it is probable that an impression is also transmitted to the hemispherical ganglia, and that the sensation of pain which the animal is undoubtedly capable of feeling resides there. These ganglia constitute, therefore, a true sensorium in the literal meaning of that term. The animal is endowed with such a high degree of functional activity—far higher in this respect than some members of the vertebrate division—that we must assume the existence of an organ to correspond in function to the ganglia which constitute the brain in fishes. The difference between the brain of a fish and that of a lobster seems to be, that in the former, the cells which minister directly to the excito-motor function—those through which impressions from without are followed directly by action in some form—are mixed and more intimately connected with the cells whose higher function it is to direct and control all

the other nerve-cells in the body, and give the animal its sensational and psychical functions; while in the latter the two kinds of cells are separated. A lobster without the hemispherical ganglia would be a mere excito-motory organism, capable of no sensation, properly so called, and showing no desires or instincts, that would move in answer to impressions on its nerves of common and special sense, and only in answer to those stimuli.

A careful consideration of the minute structure of the nervous system of any invertebrate animal, such as the one we have just been examining, shows us that histologically and physiologically the vertebrate and the invertebrate animals are nearly allied. In every essential point the ganglia and inter-ganglionic cord of the lobster correspond to the spinal cord of the vertebrate, while the cephalic ganglion is analogous both in structure and function to the brain. The tendency to segmentation seen in both sub-kingdoms is most marked in the nervous system of the invertebrate, because in this division the nervous system does not form the centre round which all the other parts are developed, as is the case with the spinal axis of the vertebrate. Such an examination makes us esteem lightly, too, such generalizations of the mere external form of the nervous system, as that made by Audouin and Milne-Edwards in the Crustacea. No doubt they were useful, as the Linnæan classification of plants was useful, as a prelude to a more natural and scientific classification; but that we are to conclude an animal to be high in the scale, merely because its nervous system happens to be compressed into a mass to accord with the external shape of the body, seems as rational as to affirm, that the nervous cord of the earth-worm and nematode is more analogous to the spinal cord of the vertebrate than that of the lobster, because it happens to have ganglionic cells all the way down.

Description of Plates.

PLATE I.*

Fig. 1. Cross section of sheath of interganglionic cord.—*a*, Outer longitudinal layer of fibres; *b*, inner circular layer; *c*, nerve-tubes cut across.

* The original drawings for the Thesis were made by my friend Dr Sibbald, from my own sketches, and with the microscopic preparations before him.

Fig. 2. *a*, Nerve-tubes of different sizes from interganglionic cord. What appear to be minutely striated fibres at one end, are at the other (where there are fewer of them) seen to be merely smaller tubes; *b*, a large tube split up into fibrillæ; *c*, nerve-cells from caudal ganglion; *d*, the same, with what appear to be stellate nuclei.

Fig. 3. *a*, Small cells from cephalic ganglion; *b*, one of the nuclei from a hemispherical ganglion.

Fig. 4. Cross section of abdominal interganglionic cord.—*a*, Large nerve-tubes; *b*, sheath, which is thickened on the dorsal surface at *d*; *c*, septum; *e*, the motor-nerve, which springs from the cord between the ganglia, lying at this part in apposition to it.

Fig. 5. Section of about one-fourth of a thoracic ganglion.—*a*, Longitudinal fibres of interganglionic cord; *b*, fibres of lateral nerve; *c*, cross fibres from one lateral nerve to the opposite side; *d*, fibres from longitudinal cord joining lateral nerves; *e*, sheath; *f*, a group of cells, with most of their fibres passing towards the head; *g*, another group, with fibres passing across to opposite side; *h* and *i*, large nerve-cells; *k* and *l*, scattered bipolar nerve-cells; *m*, a bundle of nerve fibres cut across.

Fig. 6. A section of the same ganglion as that from which fig. 5 was made, but more towards its dorsal surface.—*a*, Interganglionic cord; *b*, lateral nerve; *c*, a group of cells whose "pedicle" passes backwards towards the caudal extremity; *d*, another group, whose "pedicle" passes to the opposite side; *e*, longitudinal fibres cut somewhat obliquely; *f*, isolated nerve-cells.

Fig. 7. Diagram of an ideal ganglion, embodying the results of all the sections made.—*a*, Longitudinal fibres; *b*, cross fibres; *c*, fibres from longitudinal cord to lateral nerves; *d*, *e*, fibres of "reinforcement;" *f*, group of cells sending its "pedicle" forwards, but with connections to other groups; *g*, group of cells sending its "pedicle" to opposite lateral nerve; *h*, group between the cords, sending two bundles of fibres, *m* and *n*, to lateral nerves of opposite sides; *k*, group of cells sending "pedicle" towards caudal extremity; *l*, group of cells whose "pedicle" joins lateral nerve of same side.

Plate II.

Fig. 1. Cross section of thoracic ganglion, showing *a*, *b*, lateral nerve (in outline) cut across; *c*, a few of the fibres of longitudinal cord cut across; *d*, *e*, groups of cells whose pedicles pass to opposite side; *f*, group with pedicle passing to lateral nerve of same side; *g*, group whose connections have been cut away.

Fig. 2. Longitudinal section of an abdominal ganglion.—*a*, Longitudinal cord; *b*, lateral nerve cut across; *c*, group of cells, a few of whose fibres pass among the longitudinal fibres, and at *d* join them; *f*, other groups of cells, whose fibres converge towards the lateral nerves.

Fig. 3. The two cords connecting the cephalic to the first thoracic ganglion, with the sheath taken off one of them, magnified four times.—*a*, Ganglionic swelling at root of pneumogastric nerve; *b*, pneumogastric

The preparations were also examined by Professor Goodsir, before the "Defence of the Thesis." I must here express my great obligations to Dr Sibbald for the manner in which the illustrations were done.

Fig. 1.

Fig. 2.

Fig. 3.

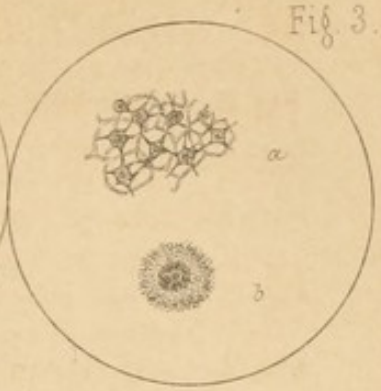

Fig. 4.

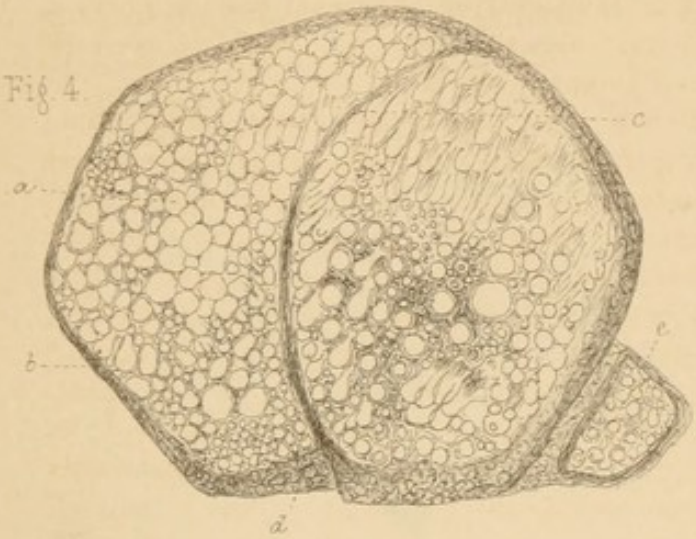

Fig. 5.

Fig. 7.

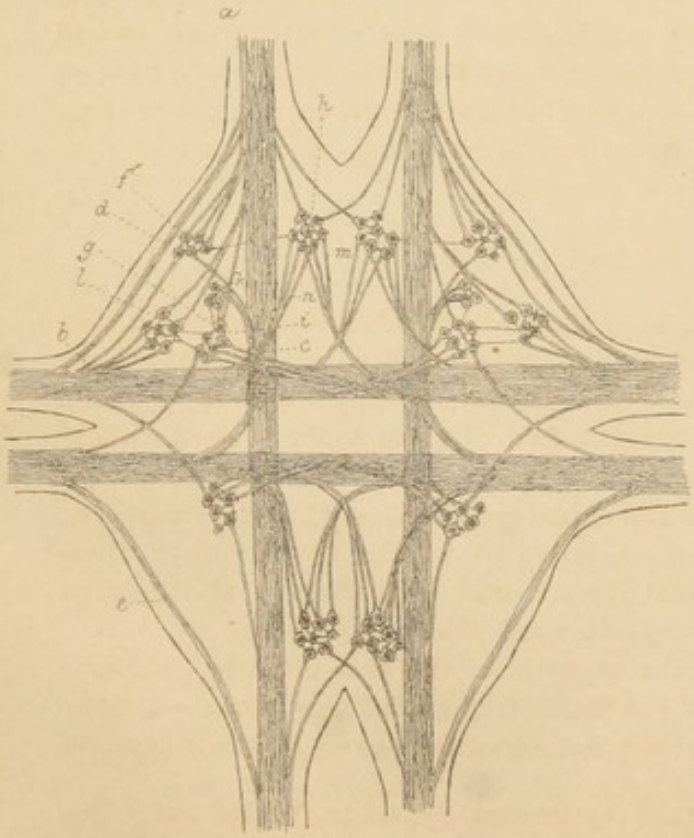

Fig. 6.

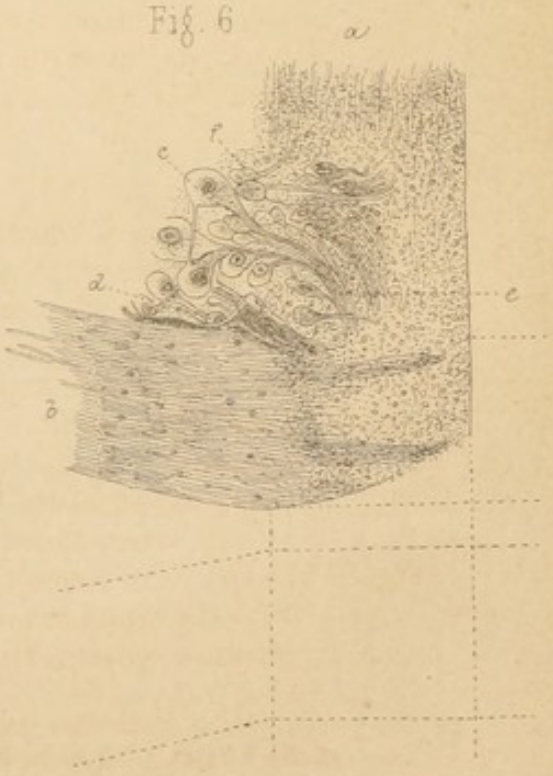

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Fig. 1.

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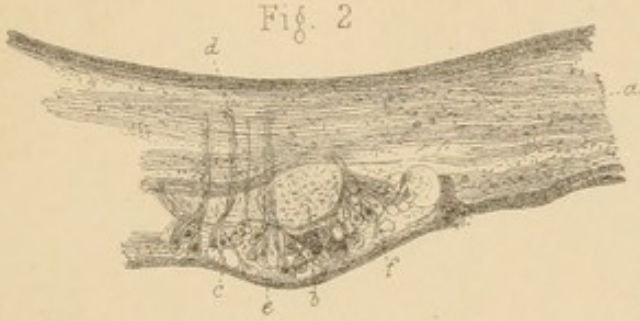

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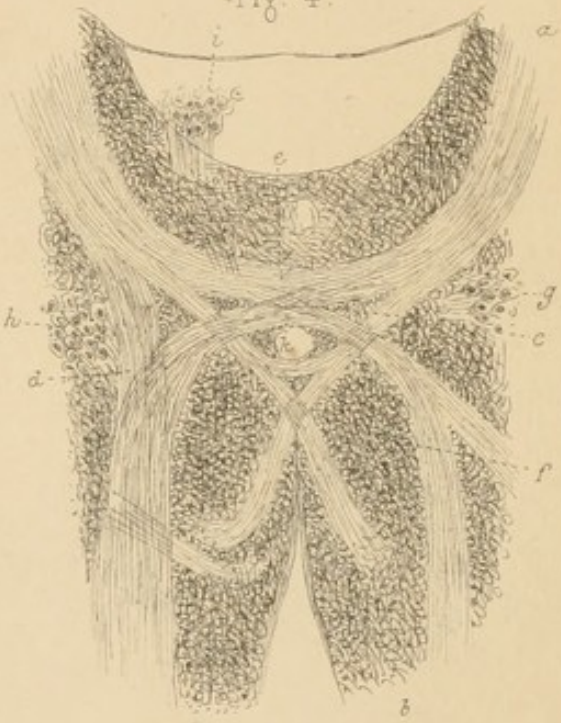
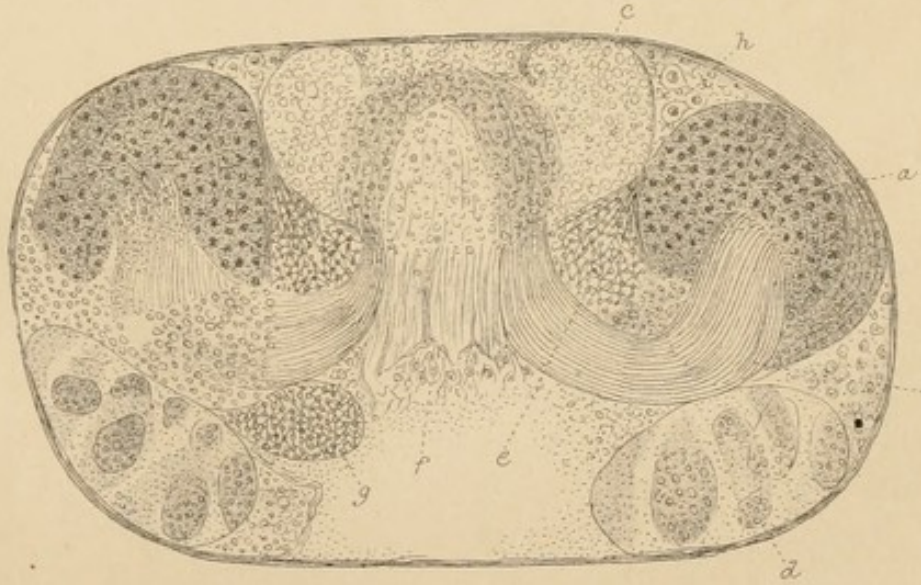


Fig. 6.

Fig. 5.



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nerve; *c*, one cord, with its sheath dissected partly off; *d*, other cord; *e*, cross nerve from one to the other, whose fibres, *g*, are dissected away from the cord, so as to show how they join the pneumogastric ganglion and nerve; *f*, accessory pneumogastric.

Fig. 4. Section of cephalic ganglion in the plane of entrance of longitudinal cords and optic nerves.—*a*, Optic nerve; *b*, longitudinal cord; *c*, fibres from longitudinal cord of opposite side to optic nerve; *d*, fibres to optic of same side; *e*, commissural fibres of optics; *f*, fibres from second cephalic nerve; *g*, *h*, groups of ordinary ganglion cells; *i*, group of ganglion cells in front of optic commissure (the whole space vacant in the drawing had been filled up by those cells, but they had been dislodged); *k*, a few commissural fibres from one longitudinal cord to the other.

Fig. 5. Cross section of the cephalic ganglion, slightly anterior to the centre.—*a*, "Hemispherical ganglion;" *b*, "Peduncle;" *c*, longitudinal cord cut across; *d*, oval striated mass below hemispherical ganglion; *e*, group of small stellate cells; *f*, *h*, ordinary ganglion cells; *g*, another group of cells similar to those at *e*.

Fig. 6. Vertical section of anterior part of cephalic ganglion, in the line of one of the optic nerves.—*a*, Optic nerve fibres; *b*, layer of small stellate cells, which many of the optic nerve fibres join; *c*, hemispherical ganglion; *d*, bending of the optic nerve fibres over the hemispherical ganglion at an acute angle.

TUMOURS OF THE BRAIN

AND

THEIR RELATION TO ITS MENTAL FUNCTIONS.

Tumours of the brain have long been recognised as a cause of insanity, but different authors have regarded them in very different lights. Arnold[1] quotes Morgagni and Bonetus, that tumours are one of 47 pathological changes found in the brains of the insane. Esquirol[2] mentions them as among the morbid conditions found in the brains of the insane, but did not connect them with any particular symptoms. According to French statistics they occurred in the form of cancer in 22 out of 8,289 cases, that is, about 2·7 per 1,000. Dr. Sutherland[3] mentions that he found 4 in 200 cases, or 20 per 1,000 cases. Tuke and Bucknill[4] say that they only found 1 tumour in 400 autopsies, or 2·5 per 1,000. Leubuscher found tumours of the brain in four cases out of 358 autopsies,[5] or at the rate of 11·5 per 1000. Fischer found not one case of tumour in 318 autopsies at the Prague Asylum.[6] At the Carlisle Asylum we have performed 214 autopsies, and there have been 6 cases of tumours of the brain, which is at the rate of 28 per 1,000 cases.

We have the experience of both the special writers on insanity and of ordinary writers on physic, as to the mental symptoms produced by tumours. Of the former Griesinger[7] mentions melancholy or maniacal excitement at the beginning, and profound dementia at the end. Dr. Maudsley[8] mentions acute delirium and imbecility as symptoms, and remarks on the fact as being important, that we do not meet with any

[1] "On Insanity," vol. i., p. 294. [2] "Maladies Mentales." [3] "Croonian Lectures." [4] "Psychological Medicine," p. 483. [5] "Pathologie und Therapie der Gehirnkrankheiten." [6] "Pathologisch-Anatomische Befunde in Leichen von Geistes Kranken. [7] "On Insanity," Syd. A. So. Trans., p. 430. [8] "Physiol. and Pathology of the Mind," p. 389.

of the recognised forms of insanity in those cases. Dr. Blandford[9] says that they chiefly cause feebleness, wandering and dementia, or delirium and coma, but he thinks that where such mental symptoms occur with tumours there will be found a hereditary tendency to mental derangement. Dr. Mackenzie Bacon[10] relates a case of a large tumour of the brain in a congenital imbecile, in which there were no symptoms but a gradually increasing stupidity. Mr. Adam Addison[11] gives a sort of torpor of the intelligence as the chief symptom of brain tumours.

Of the latter class of writers, Dr. Abercrombie[12] mentions many mental symptoms as occurring with tumours, such as dulness of the intellect, impairment of the memory, delirium, and coma, but he does not differentiate the mental symptoms of tumour from those of other organic diseases of the brain, and he mentions no mental symptoms at all in most of his cases. Andral and Durand-Fardel inferred from the cases analysed by them that there are no mental symptoms in most cases. Calmeil found that the intellect was disordered in one half of all the cases of tumours and other organic diseases of the encephalon, but then this may be accounted for by a considerable part of his experience having been derived from lunatic establishments. He says that dementia and delirium are rarely observed; that there is usually obtuseness of comprehension, and loss of memory sometimes. White softening, he says, is most like tumours in mental symptoms. Dr. Walshe[13] remarks that the cases of latent cancer prove that it is much less the new formation than the accidental modifications to which it gives rise, which produce the mental disturbance, and that the functions of sensibility and intelligence are commonly modified, but not in a uniform or characteristic manner. Niemeyer[14] says that there is no symptom occurring during the course of a cerebral tumour that does not sometimes occur from abscess or some other local cause. For psychical disturbances to be manifested, he says that both hemispheres have to be affected. Russell Reynolds[15] says the intellectual changes in the case of tumours are of two kinds, one being irritability, a condition totally different from the previous habit of the individual, rarely mild delirium or con-

[9] "Insanity and its Treatment," p. 82. [10] "Jo. Ment. Sci.," vol. x., p. 74. [11] "Jo. Ment. Sci.," vol. 8, p. 59. [12] "On the Brain," p. 32. [13] "On Cancer," p. 491. [14] "Practical Medicine," trans. by Humphreys and Hackley, vol. ii., p. 236. [15] "System of Medicine," vol. ii., p. 479.

fusion of thought; the other being loss of memory, impairment of intelligence, depression of spirits, and listlessness.

I think, therefore, that on the whole we may conclude that the subject of the relation of mental symptoms to tumours of the brain is by no means one of the definitely settled and exhausted fields in medicine, and that any clinical record of such cases cannot be considered as useless. I shall therefore proceed in the first place to relate the six cases that occurred among my 214 autopsies, and then to give an analysis of a number of recorded cases of tumour of the brain, with special reference to the mental symptoms connected with them.

No. 1.—J. R., admitted March 23rd, 1868, male, æt. 38, married, reads and writes, from Carlisle, butcher; first attack of insanity; no hereditary predisposition so far as can be ascertained; was intemperate in his habits, which is given as the predisposing cause of his insanity, the exciting cause being evidently organic disease of brain; has shown symptoms of insanity for four years. His first mental symptoms seem to have consisted in a change of temper, great irritability, and an altered affection to his wife and family. His first bodily symptoms were intense cephalalgia and a gradually increasing blindness, and this last symptom preceded by some time the mental alienation. He has been getting much worse mentally, being excessively irritable, violent to his wife and daughters, very abusive and foul in his language, and then accusing his wife of all the violence. He has still drunk hard when he could get it, and all his mental symptoms were very much worse after drinking, but he was sorry for all this afterwards. The blindness became complete, and he became slightly deaf shortly before his admission. During the twelve months before admission he had had several epileptic attacks. He wished to go to the asylum, and walked up with a friend.

On admission he showed slight signs of excitement and confusion of mind, but his memory was good; he was quite coherent, and, on the whole, sharp and intelligent; could answer questions correctly, and had no delusions. He was a heavy-looking man, with the blind expression of face, his features combining the expression of an advanced general paralytic and a man who is drunk. Brown hair, muscles and fat normal; his gait was affected like that of a tipsy man, his speech was thick and rather indistinct. He was quite blind, and deaf in his right ear. He said he had at times cramp in his legs; reflex action in legs normal. Right pupil

more dilated than left, and both nearly insensible to light. Lungs and heart normal; appetite good; tongue very white; bowels costive; temperature, 97·8; pulse, 72, good; height, about 5ft. 8in.

He remained in the state described for the first fortnight, except that on the very slightest provocation he became wild with passion, completely losing control over himself, and capable of doing any violence to those about him. On the 6th of April he had a severe epileptiform fit, being quite unconscious after it, but he was as usual next morning. He had those attacks frequently ever afterwards. For the first six months there was little change in him; after that he got more obtuse in mind, weaker and more paralysed in his legs, his articulation thicker and more indistinct, his pharynx more insensible and paralysed, so that he would have choked himself on any solid food. In nine months his legs were quite paralysed, his conjunctivæ got at first injected and then ulcerated, with ulcers of the cornea. During nearly the whole time he lived, an excessive irritability with violent paroxysms of passion often coming on without any cause were his chief mental characteristics. Towards the end of his life a clouding of his faculties took place, he slept much, and immediately before death he was semi-comatose. Reflex action in his legs continued very acute to the last. He died on the 17th January, 1869, ten months after his admission, and about five years from beginning of disease.

Autopsy.—68 hours after death.

External Appearances.—Body in fair condition, ulcer of right cornea.

Head.—Calvarium hard and heavy but not very thick. When it was removed a very curious appearance was presented. Over the surface of the dura mater there were a great many little cauliflower-like excrescences, scattered irregularly, but most numerous along the middle line, and the largest being in the locality of the Pacchionian bodies. The base of each was surrounded by a bulging of the dura mater, and where attached to this, each was quite small, forming a short pedicle. They varied in size from a pea to a bean; they looked like little projections of brain that had been made to squirt out through small holes in the dura mater, by slow, steady pressure from within—little herniæ of the brain. Each had a very thin fibrous covering, continuous with the dura mater. In colour they resembled a mixture of grey and white substance; in consistence they seemed to be nearly that

of ordinary brain convolution. Each had a clearly-cut bed absorbed out of the bony skull cap, only leaving a transparent plate of bone. There was a very large one over the right orbital plate, the size of a bean, causing complete absorption of the bone, so that it projected into the fat behind the eye. On attempting to raise the dura mater it was found that this could not be done without tearing the connection of these herniæ with the convolutions. At the narrowest part of the neck of each, as it passed through the dura mater, it consisted of little white and grey matter, so that when torn off there was a small white spot like a pin's head in the convolution from which it sprung. On section it was seen that this white substance passed through the grey matter of the convolution like a stalk, and was continuous with the ordinary white brain substance, and outside of the dura mater it extended into each hernia, swelling out and forming its centre, with a thin covering of grey substance. By gentle pressure from without, a considerable part of some of the excrescences could be pressed back, the hernia could, as it were, be so far reduced, but this broke up to a greater extent what was evidently slightly softened brain substance already.

When the brain was lifted up a large tumour was found attached to the right side of the cerebellum and along part of the right crus cerebri, pressing on and causing partial absorption of that part of the pons Varolii and cerebellum. It was firmly attached to the fibrous portion of the temporal bone, causing absorption of the bone, and entering into and disorganizing the internal ear of that side. It pressed on the lower portion of the middle lobe of the cerebrum, causing complete ramollissement there, so that the fluid in the ventricle ran out at that part when lifted. The tumour was hard and fibrous in some parts, soft and cystic in others, grey in colour, and somewhat irregular in outline, being altogether about as large as a hen's egg.

The ventricles were much enlarged and contained much fluid. On section there were spots of ramollissement over right orbit, at base of middle lobe of right side, and in corpus striatum of right side, the white substance being generally doughy; optic nerves and tracts grey and fibrous.

Microscopic Examination.—On a microscopic examination of the brain substance in the fresh state, the covering of each excrescence was found to consist of fibrous tissue, being thinned dura mater. The inside consisted of masses of granules, compound granular cells, and in some places

there was a striated appearance, the remains of white nerve fibres. The arteries were coated in most places with granular matter. On examination of the pedicles of the excrescences, the granular cells were not so numerous, and the striation of white fibres more perfect. At the surface of the brain the appearance was that of healthy white brain substance. Altogether the morbid appearances were more marked at the outside of each hernia.

On examination of sections of convolutions, hardened in chromic acid, and cut and prepared by Sterling's method, it was found that the blood vessels were very much enlarged and tortuous, and surrounded by granular matter and a great number of round vacant spaces in each section. Probably these had contained some morbid product, such as masses of granular matter which had fallen out or been dissolved by the turpentine and spirit in the process of preparation.

Chest.—Lungs free in cavity of chest. Right lung congested, above and below solid, infiltrated and friable; left, normal. *Heart*-valves competent; muscular substance dark in colour, soft and flabby in consistence.

Abdomen.—*Liver* dark in colour and friable. Other organs normal.

No. 2.—J. M., admitted 2nd June, 1870, male, æt. 44; married, mechanic; reads and writes. Had no previous attack of insanity; no hereditary predisposition to insanity. A quiet, sober, very hard-working, and saving man. No predisposing cause of brain disease or insanity known. Exciting cause of insanity evidently organic disease in brain. Been about four months insane. His first mental symptom was an irritability unusual in him, and this was noticed twelve months ago. There were no bodily symptoms present then; but he soon began to complain of pain in his head. This irritability became greatly worse six months ago, and still increased, so that it was evident his self-control was gone four months ago. Shortly after this time paralysis of the legs began to appear, and six weeks ago his sight began to fail, this symptom rapidly advancing, until he is now ordinarily quite blind, though he can see slightly at times. Lately his mental state has been changeable, being at one time that of extreme irritability—swearing and storming without any cause whatever; at another, that of great depression from the idea that he would never get well. He tried to commit suicide by

hanging himself and by jumping over a bridge. Bodily, he has been blind, deaf, and partially paralysed in his legs.

On admission, he seemed depressed, but was easily excited. Spoke quite coherently; thought that he had come to a hospital. Seemed most anxious as to what the doctors' opinion of his case would be, asking questions, and requesting to squeeze his hand once for "Yes," and twice for "No." He said if the doctor thought he was not to recover that he would greatly wish to get a dose of poison rather than live in such a miserable state.

His appearance was that of a well-built, intelligent-looking working-man, his features being heavy, and he had the "blind expression" markedly. Was dark complexioned, had brown hair, brown eyes. Muscles flabby, was in fair condition; legs partially paralysed, so that he walked insecurely and in a straddling way. His speech was thick. One side was not affected more than the other. Reflex action acute, pupils not quite circular, dilated and insensible to light; almost equal in size. Had optic neuritis most severely. Was perfectly blind, and quite deaf. Lungs and heart healthy; pulse, 96; tongue clean; appetite good; bowels costive. M.T., 97; E.T., 96·4; height, about 5ft. 7in.; weight, 138lbs.

After admission, from the first month he remained much in the state described. He was impatient, querulous, and fretful, mentally. There were no delusions. He talked much to himself, swearing and bemoaning his lot. At times he would get into ungovernable passions, striking the sofa on which he was sitting most violently. When patted and soothed, he seemed to appreciate the sympathy, and would cry bitterly and beg that he might get poison or have his throat cut if his disease could not be cured. His whole state was calculated to excite much pity. He seemed to hear a little at times. He ate and slept well, and gained five pounds in weight in the first month. His evening temperature was very low, seldom being 97°, and at this time lower than morning temperature. His pupils were sometimes contracted, and at other times dilated irregularly. His sense of touch was much impaired, not being able to tell exactly what part was touched.

He gradually became weaker and more paralysed, until in four months after admission he was unable to walk alone at all; he had lost about 20lbs. in weight, his pulse was weaker, his articulation so thick (like a very drunken man) that it could scarcely be understood at all, the pharynx was evidently much

paralysed, so that he had a difficulty in swallowing, and had to be fed entirely on soft food and minced meat. Once he was on the point of being choked. He was always most greedy for his food. There was no paralysis of the sphincters, either of the anus or bladder. Touch still more impaired, but reflex action normal. Mentally, all his faculties became more blunted, and he got into a sort of chronic but more feeble excitement, groaning, moaning, swearing, and striking the sofa. He dozed most of the day. His facial expression was remarkably like that of a very intoxicated man in a rage. About five months after admission he had the "insane ear," first the right and then the left. He frequently had attacks of stupor, falling down, but with no marked convulsions. He remained in the state I have last described for about six months, and then became so weak that he had to lie down; could not sit up in the corner of a sofa any longer, and had to be kept in bed, his legs especially being completely paralysed, but reflex action remaining; conjunctivæ got injected and ulcerated. He got more and more into a state resembling coma, and had one or two slight "congestive attacks," with a high temperature, and died on the 8th of August, being fourteen months after admission, and two years and two months from the commencement of the disease.

Autopsy.—34 hours after death.

External Appearances.—Body rather thin. A bed sore over sacrum. Ears partly shrivelled.

Head.—Skull cap thin. Dura mater not abnormally adherent, but was thick and leathery. On the left side, about the line of junction of the parietal and occipital bones, there was a small cauliflower excrescence of what seemed to the naked eye to be mixed grey and white brain substance about the size of half a marble. There was a corresponding depression in the bone, sharply defined where there was only a translucent plate of bone remaining. It looked exactly like a portion of brain squeezed through a small hole in the dura mater which adhered to the brain at that point only. On section the left hemisphere was generally doughy, and had a spot of red softening in front of the corpus striatum. At the point where the excrescence projected through the dura mater it was seen to be a part of a convolution. The right hemisphere was much softened, the white substance of part of the anterior hemisphere being almost diffluent (white softening). There were no granulations in lining membranes of lateral or 4th ventricles.

There was a soft cancerous-looking tumour attached to the right side of the pons Varolii and upper part of the medulla, about the size of a pigeon's egg. Its surface was rough, its substance in most places firm, but in other parts softened, the firm parts being grey in colour, and the soft parts dark and bloody. It was in contact above with the cerebellum, but not attached to it, though there was an indentation in which it lay, which was softened. On the left side of the cerebellum, attached to and imbedded in it, there was a similar tumour, rather less in size. This was in contact with but not adherent to left side of pons. There was much pigment on outer surface of medulla. The whole of the pons was softened, and also the upper part of the medulla.

The optic nerves and tracts were hard, and chiefly composed of grey fibrous matter. The roots of 5th pair seemed softened on both sides. The roots of 8th and 9th seemed normal.

The arteries of brain were atheromatous.

Brain weighed 55¼oz., right and left hemispheres being equal. Pons and cerebellum (including tumours) 7¼oz.

Chest.—Right lung adherent and congested below. Left, congested above, and below quite solid, the lower part containing several gangrenous spots, with inflammatory, purulent, and tubercular products mixed in nearly all the lower lobes.

Heart.—Muscular substance somewhat fatty.

Abdominal organs almost normal.

Microscopic Examination of Hardened Brain.—The convolutions near the excrescence were examined, and the sections showed a great many clear spots, as though the brain were atrophied or absorbed in these places. These occurred in the grey matter. The arteries were large and surrounded with granular matter. Through the grey matter there were enormous numbers of small irregular-shaped granular masses. These disappeared when the sections were cleaned with turpentine, but were well seen during the process of cleaning. They were well seen when they were cleaned by chloride of calcium. The excrescence itself was so soft on the outside that when hardened it broke down into powder and would not cut. It was seen to consist of granular masses more numerous, larger, and more irregular than those in the convolutions, mixed with larger tortuous blood vessels, and some half broken down white fibres, inside near the dura mater it was quite striated to the naked eye, and consisted of white fibres mixed with large blood vessels and much granular matter.

No. 3.—M. W., admitted 12th April, 1871; female, æt. 47; married; cannot read or write; from Carlisle; wife of a cotton spinner.

First attack of insanity; no hereditary predisposition; of a cheerful, easy-going disposition, but latterly irritable; habits, formerly industrious, latterly idle and intemperate. The predisposing cause of her insanity was supposed to have been change of life, and the exciting cause organic disease of the brain. The first symptoms dated from five years before admission. Her first mental symptoms were a change of habits and disposition, becoming irritable, and taking to drink, getting slovenly, idle, and careless of her household duties. There were no bodily symptoms present at first. She got worse mentally; began to lose herself sometimes about two years ago, getting more and more irrational and irritable, once threatening the children with a knife. She was always worse, mentally, after the epileptiform fits which she began to take two and a half years ago. Has had about six fits since then. Sight began to get impaired 21 months ago, and this has gone on to complete blindness for the past two weeks.

On admission she laboured under slight depression and a sense of fear; her mind was much enfeebled and confused; she mistook the identity of those about her; her memory about many things was fair; she was coherent on some points and at some times, at other times and on other points she was incoherent. She could answer questions put to her, and her only delusions seemed to be as to the identity of those about her. Was a stout woman, with a vacant blind expression, dark grey hair, blue eyes, muscularity average, fatness considerably above average. She was partially paralysed in her legs, so that she could not walk without assistance, and she felt generally weak. Reflex action was abnormally acute. Pupils equal and sluggishly contractile. Was quite blind; could not even distinguish light from darkness. Hearing and touch normal. Lungs and heart normal. Pulse 66. Tongue has a slight grey fur with red papillæ, was steady when put out. Bowels regular; appetite good. Temp. 97.6; about 4ft. 11in.; weight 126lbs.

The day after admission she was in a confused state of mind, not being able to distinguish night from morning, fancied she was in a village near Carlisle; thought those about her were old friends, and talked in an abnormally jolly and happy way; was garrulous and silly. She had slept

well; appetite good. M. temp. 97.8; E. temp. 96.4. On the 27th April (two weeks after admission) she had a fit, apparently in all respects like an ordinary epileptic fit, and was very irritable and restless after it. Sometimes did not sleep, but 20 grain doses of chloral always procured comfortable sleep and seemed to calm her irritability and restlessness. At times she could walk quite well, at other times not.

On the 31st of May she was most restless and irritable and violent during the night. She had a severe fit on the morning of the 2nd of June, remained stupid after it, vomited, and could take no food that day, and died quite suddenly and quietly in the middle of the day, looking blue in the face at the time, having no convulsive attack immediately previous. The disease had lasted five years and two months.

Autopsy.—25 hours after death.

External appearances.—Body fat; face and lips slightly dark-coloured.

Head.—Scalp very vascular; skull cap normal; dura mater dry-looking. A greyish tumour showed itself about an inch and a half from tip of the anterior lobe near the middle line. The convolutions were stretched over it, and thinned round the point where it showed itself. This tumour was found to be of large size, being about the size of a large orange, of slightly irregular outline and uneven surface. It had only a very slight connection with any part of the left hemisphere which surrounded it, and had no root or pedicle or other special relation to any part of the brain. It had been nourished by blood-vessels passing into it all round it. So far as could be ascertained, it had originated near the island of Reil. On section it was of a softish lacerable consistence, considerably harder than ordinary brain tissue. It was of a greyish white colour, exactly like a medullary tumour. The convolutions, where stretched over it, were much softened, those of middle lobe less so. The corpus striatum and optic thalamus of that side were also softened. The posterior lobe seemed normal in consistence but pale. The anterior lobe of right side was somewhat atrophied and pushed over by the tumour. On section it was pale in colour and slightly soft in consistence. The posterior lobe was normal. The cerebellum and pons were very soft and lacerable indeed. Brain weighed 47½oz.; right hemisphere, 18oz.; left (without tumour), 18¼oz.; tumour, 6½oz.; cerebellum and pons, 5oz.

Chest.—Both lungs adherent by old adhesions, and congested.

Heart.—Flabby.
Abdominal organs normal.

No. 4.—T. G., admitted 10th August, 1869; æt. 35; male, single; from Carlisle, joiner. First attack. Has a sister imbecile; father was intemperate. Was always weak-minded, but earned his living as a joiner until three months ago, when, without any exciting cause, he became more stupid in mind, took a fit, then became restless and violent and sleepless.

On admission he seemed entirely imbecile in mind, with no memory; was quite taciturn, could only answer the simplest questions; did not express any delusions. His face was entirely expressionless. He seemed feeble; muscles flabby and feeble; fatness average. He walked quite unsteadily, like an advanced general paralytic, but there was no trembling or twitching of muscles of face or tongue. He articulated very badly. His sight was much impaired. After admission he went about the ward all day, staggering and straddling in his gait; was irascible and emotional, but had no delusions. He steadily became more feeble and more unsteady, and lost all control over his sphincters. He still could see a little. In three months after admission he was weak and had to lie in bed all day; the conjunctiva of his right eye ulcerated; his pupils became insensible to light; reflex action became much impaired; and he died on the 13th of October, about six months after the first symptoms were observed.

Autopsy.—44 hours after death.

Head.—Calvarium much thicker in front than elsewhere, the frontal bone being half an inch thick; membranes dry looking. On the pons Varolii under the right crus cerebri there was a hard tumour about the size of a pea. On section it had an outer layer of what looked like ordinary white-brown substance, and its centre consisted of a yellowish hard substance, surrounded by a congested fibrinous layer. The optic nerves were enlarged, gelatinous looking, and of a pale colour. On section no trace of ordinary nerve substance could be seen in them. The optic commissure was in the same state. The tracts were a mass of soft gelatinous substance, with a slight trace of nerve tissue. In the course of the optic tracts of each side there was a tumour like the one on the crus cerebri; the two being symmetrical. The ventricles were much enlarged. Both optic thalami were almost diffluent.

The corpora striata were normal. The corpus callosum was soft, and in some parts diffluent. The medulla oblongata was flattened antero-posteriorly at its junction with the pons, and on section was found to be slightly softened there (compound granular bodies being found on microscopical examination). The upper part of medulla was adherent to cerebellum, thus obliterating the fourth ventricle. There were large projecting granulations attached to medulla. Brain weighed 46½oz.; right hemisphere, 20½oz.; left hemisphere, 20; cerebellum and pons, 5.

The foramen magnum was diminished in size by an enlargement of the odontoid process. There was also more antero-posterior motion of atlas on axis than should have been.

Spinal cord seemed normal.

Lungs congested, and bronchi contained some purulent mucus; otherwise the organs in chest and abdomen normal.

On a microscopic examination of the lower part of medulla and spinal cord, hardened in chromic acid, and cut into thin sections with Sterling's machine, they were found to be normal, so far as could be ascertained.

No. 5.—F. C., æt. 41, admitted 22nd September, 1863. Had been insane for a year and a half previously, had recovered, and had kept well for sixteen months after discharge.

On admission was confused, though to some extent rational. Bodily health seemed good. She gradually became subacutely excited with paroxysms of greater violence, but had no fixed delusions, and remained in this state for about a year. When violently excited she had an extraordinary maniacal look—her face getting purple, the veins over her neck swollen, her eyes staring and fixed, altogether looking as though in an epileptic fit. When the excitement passed off she became mildly depressed in mind for a year, and then became excited again in the same way as before, but not so violently so. In the beginning of April, 1866, she complained of sickness and headache sometimes, but otherwise had no head symptoms; she was lively, and took her food well. On April 6th she suddenly fell down unconscious, with scarcely any convulsive movements, her face and neck looking congested, her eyes staring and her pupils dilated, and was dead in a minute or two.

Autopsy.—19 hours after death.

The skull cap and membranes were normal. Grey brain substance dark coloured and congested, especially in its

outer layer; white substance was also congested. In each hemisphere there was a mass of gritty matter the size of a marble, imbedded partly in corpus striatum and partly in white substance above it. Immediately surrounding these there was a softened and dark-coloured circle, and outside of this a hardened ring of brain substance. The rest of the brain and other organs were normal. The blood was dark coloured and fluid. Brain weighed 40oz.

On a microscopic examination of the hardened brain cut into sections, the tumour itself was seen to consist of imperfectly organised matter, with cretaceous nodules in little sacs. The brain round it was filled with small oval or irregular spaces, which appeared as clear spots in the sections.

No. 6.—In the sixth case of cerebral tumour, it was cancer; secondary to soft cancer of breast.

S. S., admitted 19th October, 1866, æt. 36, female. Second attack of insanity. She laboured under melancholia at first, which afterwards changed to a sort of moral insanity, with impulsive, violent conduct. She was in excellent bodily health till she began to show signs of having cancer of right breast. This increased very rapidly, was twice removed, but returned each time. Three months before her death she lost the sight of her right eye, she had drooping of the lid, congestion of conjunctiva, dilated pupil insensible to light, and had frightful pain in eye and head. She had no cerebral symptoms before death, except the cephalalgia, at all referrible to any tumour of brain. She died on the 2nd April, 1868.

Autopsy.—24 hours after death.

Head.—A small cancerous mass about the size of a marble was found at the junction of middle and anterior lobe of left hemisphere in the convolution next the middle line. On section it was hard and grey in the centre, but gradually softened into softened brain substance infiltrated with blood. It extended through the grey and half an inch into the white, and the brain substance was softened to the extent of an eighth of an inch round it. On the under surface of posterior lobe of right side there was what seemed to be a minute nodule of cancerous deposit, surrounded by softened brain substance infiltrated with blood, the white substance being softened to the extent of three-quarters of an inch round. This part of the brain was pale and almost colourless, while all the rest was very vascular, and studded with punctæ. There was a cancerous deposit in choroid surrounding optic

nerve of right eye, and enormous cancer of lymphatic glands of axilla, neck of sternum, and lungs, and pleuræ. On a microscopic examination of the optic nerve behind where the cancer affected it, the structure appeared to be quite normal.

In the few remarks which I shall make as a commentary on those six cases, I shall dwell chiefly on the psychical symptoms which appeared to have been caused by those foreign growths in the substance of the organ of the mind. The physical symptoms produced by tumours in the brain are usually brought into the greatest prominence by authors on this subject, as we have seen. Both classes of symptoms are of the greatest possible interest, but to us, as medico-psychologists, the former naturally excite our attention most. Yet the consideration of them has this advantage to us, that our minds are forcibly directed to all the functions of the nervous system, and we must take a wider and more catholic view of such cases than that of mere specialists. They are one of a group which connect what is called "ordinary insanity" with ordinary bodily disease.

In considering those cases, the points of most interest to be kept in view are—1st, their relation to the mental symptoms, whether as a direct cause by pressure on or absorption of the convolutions, an indirect cause by setting up irritation and softening, or a still more indirect cause by acting as a stimulant to exaggerated or morbid action of the nerve cells; 2ndly, their relation to epileptiform convulsions; 3rdly, their relation to paralysis of motion and sensibility; 4thly, their duration; 5thly, their pathological nature.

Looking at the six cases, we see at once that the tumours differed very greatly in the different cases as to their relation to the mental symptoms. In this respect they are so far typical of the disease, for the history of cases of tumours of the brain exhibits a variety of bodily and mental symptoms, as astonishing as it is difficult to explain. The first four cases, however, form a group with many points in common; and of these the first two resemble each other in all respects as closely as any two cases of a specific disease. Pathologically they are, so far as I can find out, quite unique. I am not able to come on any record of the peculiar herniæ of the brain which they both had. That condition was indirectly caused by the slow and steady pressure outwards of the growing tumours. It was to me a perfectly new fact in brain pathology, that the organ had the power of so accommodating itself to such pressure that a portion of the grey and

white substance of its convolutions should pass gradually through a small hole in the dura mater, expand on the outside of it, in a secondary cranial cavity it had made for itself by absorption of the skull cap, and still retain any sort of resemblance to its normal consistence. That this was the process was clearly shown by the stalk of white matter that passed up through the grey matter, and connected itself with the herniæ. Undoubtedly, as was shown by the microscopic examination, the grey matter that had taken so unusual a journey, had got sadly damaged in structure, and no doubt also in function; but still it was not entirely unorganized; was so far from being diffluent that it looked almost exactly like unaltered grey matter.

The mental symptoms present in those two cases were, as we saw, almost exactly the same, and followed the same sequence, while in both cases they so closely followed the course of the bodily symptoms of paralysis, blindness, &c., as clearly to prove that they were directly dependant on a common cause. A change in the disposition, irritability, loss of self-control, partial at first, and then entire, alternate depression and excitement of manner and behaviour, while with all this there was a perfect consciousness of the fact that there was something wrong mentally—this was the first stage; torpidity of mind, muttering to self, dirty habits, loss of interest in all things, the second; and drowsy half-consciousness, ending in coma, the third. Here we have an epitome of the life of an ordinary case of incurable insanity in all its stages, the one taking a year or two to run its course, the other, it may be, twenty. Just because there were bodily symptoms superadded in the one case, that are usually absent in the other, the analogy so far as regards the functions of the grey matter is none the less perfect. And yet this train of symptoms we find in those two cases to be solely due to physical mechanical pressure on the grey matter, this pressure weakening its nutrition at first, and soon causing alteration of its structure. In one way the history of these cases is the more interesting that no particular part of the grey substance was at first directly pressed on, but it all suffered equally, the tumours being distant from the convolutions on which the pressure had exerted such an extraordinary effect. It will be observed that there were no delusions in either case, no special hallucination or absurd notions such as popularly give a distinctive character to ordinary madness. Here we come to the distinction between these two kinds of altered working of the brain cells. And it is a very real pathological

distinction no doubt, if we could look better into the brain cells. The absence of delusion is certainly most interesting in such cases of brain tumour, chronic abscess, or any slowly growing pressure. Pressure from within or without, applied suddenly to a brain in healthy working, will often be followed by delirium and delusion, if it is not so intense as to cause unconsciousness. Why this should be the case is I fear impossible as yet for us to explain in the present state of nerve physiology and pathology. The irritability and partial loss of self-control at first seen in those two cases we know to be the almost constant accompaniments of impaired brain nutrition. It would be interesting to know if these mental symptoms were caused by the pressure alone, or only showed themselves when the pressure had been sufficiently long applied to be causing structural change. The blindness having occurred so long before the mental symptoms in J. R.'s case, would certainly favour the latter theory. The depression present in J. M.'s case seemed to be quite natural in the circumstances, but it has been remarked by an Italian writer that mental symptoms generally, and especially depression, are apt to be present in cases of tumour of the pons.

The speech in these two cases was affected in a very similar way to the speech of general paralysis. I cannot help thinking that if our knowledge of brain pathology were sufficiently advanced we should find that the nerve centres that regulate the articulation and facial expression are affected in the same way in general paralysis and in such cases.

In both the cases the appetite was good almost up to the time they died. Their power of digestion, too, seemed to be fair, though their furred tongues and loss of weight in the later stages of the disease showed that nutrition was impaired. The cry of all the tissues of the body for nourishment, as represented by craving for food, would really seem to be independent of the brain. Certainly in those cases where every part of the brain was more or less affected by organic disease, and none of its functions were unimpaired, this desire remained strongly marked. It will have been observed that J. M. gained weight considerably at first, and had then no increase of temperature, and no raised evening temperature. The "insane ears" that were present in J. M.'s case are interesting, as showing that the state of the blood vessels was very analogous to their condition in general paralysis and extreme dementia. The absence during all the first period of the disease of any inflammatory tendency, as represented by an increased even-

ing temperature, is curious, and very contrary to what I should have expected.

If we now consider the third case, that of M. W., we see that it differs little from the others in mental symptoms. Irritability, loss of self-control, altered character, were all present. Death having taken place at an earlier period of the disease, there could be no comparison between her state and that of the two others in the later stages of their disease. Her mind was unquestionably weaker than theirs in all respects, and this would seem to be accounted for by the tumour being up more among the convolutions, pressing on them directly. Her mistaking the identity of those about her, and fancying she was in a neighbouring village, was more a mark of weakness of mind than a real delusion, considering she was blind. The greater tendency to epileptiform convulsions in her case and in that of J. R. (No. 1) agrees with what Niemeyer has remarked, that the more the disease affects the convolutions the stronger this tendency is. This does not strengthen Schroeder Van der Kolk and Brown Sequard's theory, that the medulla must be looked on as the primary seat of epilepsy. It would rather seem as though the seat of the original impulse or irritation that causes an epileptic fit were in the brain convolutions, transmitting a strong impression down to the medulla. The tumour not being so near the large cerebral ganglia that preside over motor and sensory life, it would have been supposed that she could have walked better, and that the special senses would have remained unimpaired. It was not so, however, as we saw. In regard to the blindness I shall consider it afterwards. Her mental condition, in many respects, resembled that of general paralysis.

The fourth case, that of T. G., was in its symptoms more like a case of ramollissement of the brain. The mental symptoms present could not be attributed to pressure like the three preceding, and there was a considerable difference between him and the others psychically. There was not the same irritability and loss of self-control present at first, but rather a rapidly increasing imbecility, with some amount of irritability. The fact that he had been rather imbecile always may have affected the mental symptoms in this case. It was the only case in which there was any hereditary tendency to insanity. The curious repetition of the same kind of small tumours in different parts of the brain, the evident solidarity of those with the degenerations of the optic nerves and the ramollissements, are important pathological facts.

In all the first four cases there could be no doubt that the mental derangement present was the direct result of the tumours and the pathological changes in the brain caused by or accompanying them. In the fifth case, that of F.M., this is not so clear. The insanity was really an ordinary attack of mania. It had occurred on two occasions, and she had recovered her mental soundness between them. There were no motor or sensory derangements pointing to any general affection of the nervous system. The two tumours or deposits were small and apparently of old standing, being in a part of the brain that is not directly connected with any of the great functions of life. It is doubtful if they could directly have caused the insanity; still, I think there can be no doubt they caused her sudden death, and, if so, might not the lesser effect of brain irritation and mania also have resulted in a reflex or indirect way? Certainly the microscopic examination seemed to show actual disease in the grey matter, but I need scarcely say to those who have either made or carefully examined sections of the grey matter, that we are far from being able to speak with certainty on this point. Tumours of the brain of all kinds have this tendency to cause sudden death. M. W. (No. 3) died suddenly in somewhat the same way. I think this must be connected with their tendency to cause severe epileptiform convulsions. In the two cases death was caused by the sudden cessation of the respiration, the heart continuing to beat for a short time. The dark colour of the skin and the fluidity of the blood showed that this was the case. No doubt the reflex centre of respiration in the medulla is by some sort of violent irritation, or some such cause, suddenly stopped from performing its normal function. There was a curious symmetrical disposition of the tumours on the two sides of the brain in cases No. 2, 4, and 5.

In the last case of cranial tumours, that of S. S., there are no mental symptoms referrible to them, as might have been expected from their small size. The chief point illustrated by them is the evident irritation in the brain substance, caused by a cancerous deposit, however small, *from the very beginning*.

It was my intention to have gone into the subject of the blindness, which was complete in the first three cases, and partial in the fourth, but Dr. Clifford Allbutt has gone so ably and exhaustively into the question in his book "On the use of the Ophthalmoscope in Diseases of the Nervous System," that it would be mere presumption in me to do so. Von Gräfe explained the changes in the optic nerves and retinæ in all

such cases by the theory of an impeded circulation in the veins, from the pressure of the tumour. The latest theory on the subject is that there exists a lymph cavity between the outer and inner sheaths of the optic nerve that is continuous with the arachnoid cavity. In all diseases, therefore, where there is an excess of fluid in the latter it finds its way into the former, and there is a pressure round the optic nerve entrance into the eye, causing a sort of œdema of the retina. This may explain the choked disc seen in some cases, but the actual structural change in the nerve which we have seen to exist in the first form of these cases is not to be so explained. It has been long known to be a most common symptom in cranial tumours and meningitis. Dr. Allbutt argues most strongly that it results from a true primary neuritis of the optic nerves, and is not to be explained either by a neurosis of the sympathetic within the skull deranging the cerebral circulation, and pressure, which is the theory of Benedikt, or by Wallerian atrophy from injury to the hypothetical centres of vision in the hemispheres, which is the theory of Lancereaux. The entire absence of increased temperature, especially of increased evening temperature, in those cases, would not support the inflammatory theory, and the fact that in case No. 6, though sight was utterly destroyed by cancer at the entrance of the nerve, yet that no atrophy was taking place in its fibres, would not support the theory of atrophy. It seems to me that it must be regarded as one of the *progressive* degenerations of nerve tissue, of which the number continues to multiply the more closely the diseases of the nervous system are studied. General paralysis, locomotor ataxy, Duchenne's paralysis, are examples. I have no doubt that many of the cases of ordinary insanity will be found to depend on a similar process affecting the cells of the grey substance alone. A case that steadily passes from maniacal excitement into weakmindedness, then into dementia, and then into the most complete absence of all the ordinary mental manifestations, the patient living the life of a congenital idiot, may often depend on such a process. Many cases of cerebral exhaustion and brain atrophy may, I think, be regarded as of this class.

All those tumours were cancerous except that of T. G. and F. M., the former of which was fibrous, and consisted of an increase of the nerve connective tissue, and the latter the result of tissue degeneration of the nerve fibres, with calcareous deposition following.

So far as any deductions can be come to from those six cases they would be something of this kind :—

1.—That irritability and loss of self-control, and a change of disposition, are the first mental symptoms of those tumours of the brain which directly produce morbid psychosis.

2.—That the depression present seems to result from the patient's knowledge of his probable incurability, and is natural therefore.

3.—That a blunting of the whole of the mental faculties soon comes on, and gradually passes into coma.

4.—That tumours growing slowly at the base of the brain may, by pressure, cause portions of the grey and white substance of the convolutions to pass through small openings in the dura mater, to imbed themselves in the cranium, and so form true herniæ of the brain.

5.—That tumours growing in the brain have three distinct effects on the brain structure. 1st, they create an irritation tending to ramollissement in the nerve substance with which they are in contact, from their first appearance. 2nd, they cause pressure on distant parts, which in its turn causes an alteration of the structure and nutrition. 3rd, they set up *progressive* disease and degeneration of certain parts of the nerve structure, the true nature of which is as yet not very well known, but it seems to be in some way directly connected with the essential nature and constitution of all sorts of nerve substance, whether cells or fibres. Its results pathologically are—an increase of the connective tissue of fatty matter, in the form of granules, and enlargement and thickening of the coats of the blood-vessels, but all these seem to be secondary changes.

6.—That there is a distinct and strong analogy between the symptoms, mental and bodily, produced by such large tumours, and those of general paralysis, which is the type of progressive degenerative diseases of the nervous system, inasmuch as it affects the brain, cord, sympathetic ganglia, and retina.

7.—That such cases would seem to hold an intermediate place, so far as mental symptoms are concerned, between acute inflammation of the cortical substance and blood poisonings on the one hand, and hereditary insanity on the other, the mental characteristics of the three being represented by delirium, irritability, and delusion respectively.

THE LOCAL DISTRIBUTION OF INSANITY

AND ITS VARIETIES IN ENGLAND AND WALES.

The way in which some diseases seem to confine themselves to particular localities and classes of persons, and the reasons for this have always been favourite studies in medicine; and year by year such questions attract more and more attention. The reason of this is obvious. Those problems have some of the definiteness of pure physical science about them: their study throws a direct light on the nature of disease, while their solution tends to its immediate prevention. Hence the prominence which they have assumed in the new branch of preventive medicine. There is scarcely any word which means so much in this science as the localisation of disease, in its active and in its passive phase. To know why a disease breaks out in a certain place, and to be able to keep it from spreading further may be said to be the two first aims of public medicine. The first thing to be done is, of course, definitely to connect the disease with its habitat. This can be done far more readily in the case of some diseases than in that of others, but there is no disease that is not more or less localised as to places or the class of persons whom it attacks. The weak points of man's constitution are so many, and the trials to which it is subjected vary so widely with locality, climate, food, work, and circumstances, that this must be so. The infinitely numerous seeds of disease and dissolution are of many species; and while each seed only germinates as it finds fit soil, each species also requires suitable conditions. This is as true in regard to the brain, and the departures from the normal performance of its higher functions, as in regard to every other organ of the body,

though as yet but little attention has been directed to this fact. The wide series of diseases which are at present called Insanity prevail more in some places than in others, attack some classes of persons in preference to others, are hurried into actual development, or retarded where latent tendencies to them are in existence, by certain things which have a local prevalence, and they evidently assume one form rather than another through local influences. The extent to which this is the case is as surprising as it is certain. When one comes to look carefully into the reports of lunatic asylums in different parts of the country it is found that there are forms of brain disease (or varieties of insanity as they are called) present in abundance in one place which have almost no existence in another. Diseases of the brain which kill more than a third of all the patients in the asylums of some of our counties do but kill 5 per cent. of them in others. But I shall not anticipate the numerical proof of what I have been stating. This investigation must be very largely conducted on the numerical method, and fortunately the distribution of insanity and its varieties can be more thoroughly made out in this way than that of almost any other disease. When it attacks in a decided form any person in the classes which constitute nineteen-twentieths of the inhabitants of this country its treatment is so difficult and costly that if it is of long duration it almost necessarily must be done at the public expense. This implies that it is publicly recorded in the official documents of the Commissioners in Lunacy and the Poor Law Board. In this way a fairly trustworthy account can be got of the number of persons in every county and district of England and Scotland who are suffering from this disease in any one year. It is true that these numbers include also the persons who are chargeable to public funds on account of idiocy or marked imbecility, dating from birth, and the numbers of the latter cannot be distinguished in these documents from those who labour under insanity. But as congenital brain defect and acquired brain disease certainly have the closest connection hereditarily and in their essential nature, this does not seriously affect an investigation into the local occurrence of insanity founded on the numbers recorded in the official documents I have referred to. The numbers of the insane who are paid for out of their own funds or by their relations, and who appear in those documents as private patients, are left out of the account, because those numbers are comparatively small, and it is

impossible to fix correctly the local occurrence of this class of insanity, it being determined in these official records more by the presence or absence of the institutions for its treatment than anything else. This omission affects slightly the scientific accuracy of the results obtained, but does not affect their practical value and medical interest.

In the still more interesting but more difficult investigation of the local distribution of the different varieties of insanity, in other words the various diseases which are included under that name, the only reliable data are the facts recorded in the county and district asylum reports. Unfortunately, these are not all drawn up on one plan, no absolutely uniform nomenclature or classification is adopted, and they have not all as yet adopted the forms of statistical tables recommended by the Medico-Psychological Society, so that this part of the enquiry cannot be made so exhaustive or complete as the other. A sufficient number of uniform facts can, however, be got from the reports of asylums, scattered over the various parts of the country, on which to base fairly reliable generalisations. I shall endeavour to throw the numbers and facts into tabular forms as much as possible for the sake of reference.

The actual number of the pauper insane in each county and district I have taken as they stood on the 1st of January, 1871, because that is the record of lunatics nearest to the census of the 3rd of April of that year. The "Preliminary Report of the Census of 1871," issued by the Registrar-General, has been used. I have given in Table 1* (see next page), amongst other information, the proportion of lunatics for every 1000 of the population in every county in England and Wales. The rate for the whole of England and Wales is there seen to be 2·2 per 1000, but the departures from this rate are very striking indeed. The minimum of 1·3 (Durham) is only about three-fifths of the average, and little more than one-third of the maximum of 3·6 at which the county of Berkshire stands. It is an astonishing fact medically, that any non-infectious disease should be nearly three times as common in Berkshire as in Durham; while it is equally remarkable and interesting socially and economically. Durham would have 2,473 madmen and idiots instead of 893 if it had the same number in proportion to its

* A table of this kind is given in p. 14 of the 25th Report of the Commissioners in Lunacy, but on account of the numbers of the population of the various counties being put down probably from the Registrar's estimate instead of from the census returns (not then issued) the proportion of lunatics per 1000 is entirely incorrect.

TABLE I.

COUNTIES.	Population. 1871.	Lunatics. 1871.	Lunatics per 1000 of Population.	Per centage of increase of Population 1861—1871.	Paupers per 1000 of Population.
England and Wales.	22,704,108	50,637	2·2	13·1	47·8
Anglesey	50,919	91	1·8	−6·8	66·4
Bedford	146,256	377	2·6	8·1	72
Berks	196,445	713	3·6	11·5	73·1
Brecon	59,904	147	2·5	−3	54·9
Bucks	175,870	441	2·5	4·7	64·3
Cambridge	186,363	446	2·4	6	73·5
Cardigan	73,488	158	2·1	1·7	92
Carmarthen	116,944	309	2·7	4 6	51·1
Carnarvon	106,122	261	2·4	10·9	75·3
Chester	561,131	959	1·7	11	29·3
Cornwall	362,098	567	1·6	−2·3	50 7
Cumberland	220,245	463	2·1	7 3	30·9
Denbigh	104,266	147	1·4	3·4	62·5
Derby	380,538	597	1·6	12·2	24·5
Devon	600,814	1,438	2·4	2·8	58 6
Dorset	195,544	489	2·5	3·6	76 3
Durham	685,045	893	1·3	34·7	36·7
Essex	466,427	1,017	2·2	15·2	67·5
Flint	76,245	202	2·8	9·3	37·6
Glamorgan	396 010	685	1·7	24·6	50
Gloucester	534,320	1,492	2·8	10	52
Hereford	125 364	414	3·3	1·3	53
Herts	192,725	516	2·7	11·2	68·6
Hunt	63,672	134	2·1	−1	52
Kent	847,507	1,864	2·2	15·5	52
Lancashire	2,818.904	5,538	2	16	32·1
Leicester	268,764	805	3	13·2	47·4
Lincoln	436,163	867	2	5·8	50·1
Merioneth	74,369	108	2·3	21·6	78
Middlesex	2,538,882	7,312	2·9	15·1	51·6
Monmouth	195,391	547	2·7	11·9	58·8
Montgomery	67,789	197	2·9	1·3	73·5
Norfolk	438,511	1,135	2·6	·9	70 8
Northampton	243,896	622	2·5	7·1	63·5
Northumberland	386,959	773	2	12·8	43·8
Nottingham	319,956	786	2·5	8·9	44·8
Oxford	177,956	556	3·1	4·1	68·7
Pembroke	91,936	256	2·8	−4·5	61·7
Radnor	25,428	45	1·8	0	89·3
Rutland	22,070	51	2·3	1	60·8
Salop	248,064	695	2·8	2·9	43·5
Somerset	463,412	1,272	2·7	4·2	71·9
Southampton	543,837	1,312	2·4	12·9	58·3
Stafford	857,333	1,264	1·5	14·8	38
Suffolk	348,479	853	2·4	3·4	70 7
Surrey	1,090,270	2,590	2 4	31·2	51·6
Sussex	417,407	1,060	2·5	14 8	61·1
Warwick	633,902	1,486	2·3	12·8	35·8
Westmorland	65,005	131	2	6·9	32·8
Wilts	257,202	806	3·1	3·2	77·2
Worcester	338,848	1,088	3·2	12·2	41·1
York (East Riding)	3·3,301	585	1·9	10·6	30 7
York (North Riding)	291,589	436	1·5	18 9	28·1
York (West Riding)	1,831,223	2,641	1·5	21·5	31·1

population as Berkshire, and would pay £47,000 instead of £17,000 for their maintenance. Other things being equal, the race in Durham should be immensely better in health and vigour and morals through not having those 1500 extra lunatics, the children they would have begotten, and the tainted families in which they would have occurred.

For the explanation of this extraordinary difference in the production of lunacy in the various parts of England, it is evident that many things will have to be taken into consideration. The lunacy rate will have to be very carefully compared with the rate of occurrence of many other things in order to exhaust all the possibilities of causation, and reliable conclusions can only be come to by weighing carefully the medical and social meaning of the figures.

1. I shall first compare the proportion of lunacy with the rate of increase of the population in the various counties during the ten years from 1861 to 1871, and to throw still more light on the question, make the same comparison in regard to the larger areas constituting the registration divisions. The rate of increase of a population is a general fact of the most important kind, which shows the vigour of race, the social habits, the health, the presence of large towns, and, above all in England, the prosperity of a county. And the exact increase that ought to have taken place from the excess of births over deaths being known, it also shows the amount of emigration out of, or the immigration of a foreign element into any district. Both of these things are most important facts to be known, for those who leave a county naturally leave their insane relatives behind them, and they commonly belong to one of two classes. Either they are the best and most pushing of their class going to better themselves, or they are the worst and least pushing who go to the large towns to sink into pauperism and social misery. Some expect that counties to which such immigration takes place will find their natural level in regard to their number of lunatics in time, and the counties from which it has taken place would scarcely be expected to decrease in population and increase in lunacy for ever; this part of the question I shall test accurately by figures, and by a comparison of the growth of population and of that of lunacy respectively in the various counties.

2. The next element of social statistics that seems to bear on the question, is the Pauperism of the counties and their Wealth. The former I shall easily compare, by showing

side by side the rate of lunacy and that of pauperism to the population in each county and district, and the latter in an imperfect way by showing the taxable wealth per person of the population. (See Tables I and II.) By this means the theory that our lunacy is largely the result of the same influences which have caused our pauperism can be tested, and the general relationship between the two, when looked at on a large scale, made out. The rate of wages of the working population, and their circumstances is another element that will be taken into account under this heading.

3. The influence of the amount and kind of Food and Drink, especially intoxicating drink, on the production of insanity, will next come under consideration.

4. Most diseases having more or less relation to the prevalent Occupations of a people, I shall next examine into the connection between the amount of insanity in the counties and districts, and the prevalent occupations of the inhabitants. I cannot pretend to do this quite fully, but I shall take all the reliable facts that can be got for the elucidation of this extremely interesting branch of the enquiry. The habits of the people come most naturally along with their occupations in their relation to this question. Nothing, certainly, can well be more important than to ascertain whether the husbandman or the cotton-spinner, the miner, or the woolworker, is most subject to this disease.

5. Closely connected with this last is the next part of this question I shall investigate, viz., the influence of living in Cities or in the Country in the production of lunacy, and the crowded or scattered state of the population, as shown by the number to each square mile.

6. The very important but not very definite facts ascertainable in regard to the effect of Intermarriages among small communities for many generations, may help to throw some light on the question, and will be taken into account, so far as the facts can be got.

7. The Geographical Position of the various counties and districts, in its relation to the amount of insanity in them, will form the next head of enquiry. The difference between the South and the North of England, between the hilly and plain districts, between those bordering on the sea and those inland, if there is any difference between any of these, would seem necessary to any complete investigation.

8. So far as it can be done, I shall also take the element of Race into the investigation, and see whether the descend-

ants of the Celt, the Englishman, or the Scandinavian, seem most liable to the disease.

9. The Healthiness or not of the counties, as shown by their death rates, and the connection of this with the amount of lunacy, will then be examined. The prevalence of Consumption, so far as this is known topographically, will also be compared with the prevalence of insanity in the same way.

10. As in individual cases there is often the closest connection between the presence of incipient insanity and the perpetration of Criminal acts, I shall compare the numbers who have been committed to prison in each county with the amount of insanity in it.

11. The relationship of the prevalence of insanity to the amount of Education, Culture, and Intelligence, so far as the latter can be estimated, will be considered.

12. Then there are certain accidental but very important facts that are well known to have an influence on the *recorded* lunacy of a district, which will demand examination, viz., 1. The presence of asylums. 2. The length of time these have been in existence in a district. 3. The distance of a district from the asylum. 4. The size of the parishes or unions.

13. Lastly, as a circumstance that directly affects, not the annual production, but the number of the insane in a county at any one time, we shall notice the presence or absence of Fatal Forms of Insanity in particular counties ; in other words, the death-rate among the insane as compared with the numbers living. If 15 per cent. of all the insane die every year in one county, and only 10 in another, the annual production of the disease being the same, then at the end of ten years the latter will have a far higher rate per 1000 of the population than the former. This will lead to the second part of the enquiry, viz., the Occurrence and Local Distribution of the chief Varieties of Insanity.

1. *The Local Distribution of Insanity in relation to the Decennial Increase of the Population between* 1861-71.

The rate of increase of the population of England and Wales for the ten years between the census of 1861 and that of 1871 was 13 per cent. In Table I. is shown the rate of increase for each of the counties, and it is seen at a glance how enormous is the difference between them. Durham stands at 35 per cent., or more than a third, while Anglesey shows a decrease of 7 per cent. The first thing that

strikes one on looking at this rate of increase of the population, and comparing it with the lunacy rate (Table I.), is that if there is any relationship between the two, certainly it is not an absolutely strict one, the latter by no means varying to the same extent as the former. But a closer scrutiny does detect the fact that by far the most of the large counties that show a very large rate of increase of the population do also exhibit a very low rate of lunacy. Durham, Glamorgan, the West Riding of Yorkshire, Stafford, and Lancashire together, have only one lunatic to 600 of population, and together have increased more than twice the average amount; while Hunts, Brecon, Pembroke, Wilts, Hereford, Norfolk, Rutland, Dorset and Oxford, with half the average rate of increase, have one to every 350. As, however, the matter requires closer elucidation, I have in Table II. placed the counties in the order of their lunacy rate, dividing them into three classes. Taking the average rate of 2·2 of the pauper lunatics per 1000 of the population, and placing all the counties which have either that rate or are within 1·2 above or below it in one class, putting those which are below 2 per 1000 into another, and all those above 2·4 into a third, we have three classes, 1st, "below average;" 2nd, "average;" and 3rd, "above average." I have placed the counties in the exact order of their lunacy rate from the lowest to the highest, for easy reference. As the Welsh counties are so small, and, with the exception of Glamorgan, so uniform in general character, I have counted Glamorgan as one county, and the rest of Wales as another, thus making 44 counties in all.

Apart from the three classes into which I have divided these, 18 of them are actually below the average lunacy rate, and 26 of them above it; Kent and Essex, which both stand at 2·2, being actually lower than the average, if these were carried out to two figures of a decimal. This irregularity in the numbers on either side of the average, results, of course, from the counties below the average being chiefly those with large populations.

In the first class, or that below the average lunacy rate, there are 9 counties, (counting the three Yorkshire Ridings as each a county) with a population of about five millions and a half, which had increased 17 per cent. in the ten years. Durham, Stafford, Yorkshire, Derby, Glamorgan, Chester, are all in this class. Five of the nine are largely above the average decennial rate of increase, three of them only very slightly

TABLE II.

FIRST CLASS. LUNACY UNDER AVERAGE. (From 1·3 to 2 per 1,000 of Population.) Nine Counties with a Population of 5,677,268.						SECOND CLASS. LUNACY AVERAGE. (From 2 to 2·4 per 1,000 of Population.) Sixteen Counties with a Population of 9,600,714.						THIRD CLASS. LUNACY ABOVE AVERAGE. (From 2·4 to 3·6 per 1,000 of Population.) Nineteen Counties with a Population of 7,426,126.					
Counties.	Lunatics per 1,000.	Decennial Increase of Population.	Yearly Increase of Lunatics.	Paupers per 1,000.	Taxable Wealth per Person.	Counties.	Lunatics per 1,000.	Decennial Increase of Population.	Yearly Increase of Lunatics.	Paupers per 1,000.	Taxable Wealth per Person.	Counties.	Lunatics per 1,000.	Decennial Increase of Population.	Yearly Increase of Lunatics.	Paupers per 1,000.	Taxable Wealth per Person.
					£ s.						£ s.						£ s.
Durham	1·3	34·7	5·8	36·7	8 0	Lancashire ...	2	16	3·6	32·1	17 4	Bucks	2·5	4·7	—1·3	64·3	7 3
Stafford.....	1·5	14·8	5·2	38	9 7	Lincoln	2	5·8	—6	50	17 0	Dorset	2·5	3·6	1·4	76·3	11 8
York (W. Riding)	1·5	21·5	5·3	31·1	12 5	Northumberland.....	2	12·8	2·1	43·8	13 1	Northampton	2·5	7·1	·2	63·5	13 6
York (N. Riding)	1·5	18·9	5·2	28·1	12 5	Westmorland	2	6·9	0	32·8	12 0	Notts.....	2·5	8·9	·7	44·8	11 8
Derby	1·6	12·2	2·5	24·5	14 8	Cumberland...	2·1	7·3	·4	39	12 2	Sussex	2·5	14·8	5·7	61·1	12 5
Cornwall	1·6	—2·3	—10	50·7	8 3	Huntingdon...	2·1	—1	4·7	52	20 6	Beds	2·6	8·1	4·7	72	11 3
Glamorgan	1·7	24·6	3·4	50	8 8	Essex.....	2·2	15·2	4	67·5	11 6	Norfolk.....	2·6	·9	5·3	70·8	13 5
Chester	1·7	11	3·4	29·3	9 8	Kent	2·2	15·5	14	52	11 2	Herts.....	2·7	11·2	4·7	68·6	12 7
York (E. Riding)	1·9	10·6	5·2	30·7	12 5	Wales (except Glamorgan)	2·3	3·3		64·9	9 4	Monmouth ...	2·7	11·9		58·8	8 5
						Rutland	2·3	1	7·8	60·8	18 6	Somerset	2·7	4·2	4·7	71·9	17 5
						Warwick	2·3	12·8	2·5	35·8	12 5	Gloucester ...	2·8	10	·5	52	7 8
						Cambridge ...	2·4	6	1	73·5	16 4	Salop.....	2·8	2·9	4·5	43·5	13 5
						Devon	2·4	2·8	6·9	58·6	10 8	Middlesex.....	2·9	15·1	5·4	51·6	27 9
						Southampton	2·4	12.9		58·3	9 5	Leicester	3	13·2	8·1	47·4	13 1
						Suffolk	2·4	3·4		70·7	12 5	Oxford	3·1	4·1	4·8	68·7	14 1
						Surrey	2·4	31·2	11	51·6	12 2	Wilts.....	3·1	3·2	·9	77·2	14 1
												Worcester.....	3·2	12·2	2·6	41·1	11 5
												Hereford	3·3	1·3		53	15 0
												Berks.....	3·6	11·5	4·8	73·1	8 2
Averages for the Classes	1·5	17	4·4	34·6			2·2	13	3·8	48			2·8	9	3	58·2	
Average for all England and Wales.....	2·2	13·1	3·6	47·8	13 15		2·2	13·1	3·6	47·8	13 15		2·2	13·1	3·6	47·8	13 15

below it; and in Cornwall, which is a decreasing county, the lunacy rate is dependant on other influences, which, as we shall see afterwards, only help to prove the general rule.

The second class of counties, or those with an average rate of lunacy, consist of 16, with a population of about nine millions and a half, that had increased 13 per cent. during the ten years, or as nearly as possible at the average rate for all England. Lancashire heads this class, having the lowest lunacy rate; and it includes Lincoln, Northumberland, Essex, Kent, Warwick, Devon, Hants, Suffolk, and Surrey. Eight of the 16 are actually lower than the lunacy rate for all England, and eight are higher, while five (all large counties), are above the average rate of increase of population, and 11 (which include all the small counties in this class) are below it.

The third class, or those above the average lunacy rate, are 19 in number, with a population of about seven millions and a half, which has only increased 9 per cent. during the 10 years. It consists chiefly of agricultural counties, but includes Middlesex, the chief metropolitan county, which differs from most of the other counties in England in regard to the want of connection between its decennial increase and its lunacy rate, but there are other influences which explain this. There are only 3 of those 19 counties that have a rate of increase of population above the average.

The general result is, that taking each of those groups of counties, the number of lunatics per 1,000 of the population is in a precisely inverse ratio to its rate of increase during the 10 years, a lunacy rate of 1·5 going with a rate of increase of 17 in the first, one of 2·2 with 13, and one of 2·8 with 9. This holds good with regard to most of the single counties too, but there are many exceptions, by far the most remarkable of which are the two metropolitan counties of Surrey and Middlesex, which are above the average in regard to their lunacy rate and also high in their decennial increase. More than half the Welsh counties, Cornwall, and six of the English agricultural counties, Lincoln, Hants, Rutland, Cambridge, Devon, and Suffolk, too, form an exception in the other direction, having low lunacy rates, and a low rate of decennial increase. The succeeding parts of the enquiry will, I think, explain both anomalies, and make these exceptions especially instructive as regards the causes of insanity.

We now take, not counties, but the registration divisions of the country, and examine the number of insane persons per

thousand of the population in each of them, as compared with their decennial increase, at the same time taking account of how this increase is made up; to what extent in the natural way from the excess of the births over the deaths during the ten years, and to what extent from the immigration of other persons who were born elsewhere. Those facts are shown in Table III. In the 5th column the decennial rate of increase is shown as actually ascertained from the census, and in the 6th column how much that increase is either above or below the "natural increase," or the excess of the births over the deaths. In the divisions where there were found to be more people at the end of the ten years than had been born there, the per centage of this excess over the natural increase is shown by a *plus* sign; in those where there were fewer persons, the per centage of this diminution is shown by a *minus* sign. All the divisions with a high *plus* per centage, therefore, had a large immigration into them of new stock from other places; all those with a high *minus* per centage lost through emigration a large number of the persons born in them during the ten years.

Beginning with the London Division we find that there the rate of lunacy is very high, 2·8, being the highest of all in fact, while the decennial rate of increase is also very high (16), though not so high as the South Eastern, York, and Northern Divisions. This increase of the population was due in a larger degree to the immigration of persons not born in the division than in the case of any other part of England, being 35 per cent. above it, or one immigrant for every two births. This fact, taken in conjunction with the very high lunacy rate, undoubtedly shows that the immigrants into London are for some reason quite as much subject to insanity, or more so, than those born there. The second or South Eastern Division, comprising the extra metropolitan parts of Surrey and Kent, Sussex, Hants, and Berks, shows a high lunacy rate (2·5), with also a high rate of decennial increase (17), and a large excess of increase (22 per cent.) over the births in the division. The third, or South Midland division, which includes the extra-metropolitan part of Middlesex, Herts, Bucks, Oxford, Northampton, Hants, Beds, and Cambridge shows a high lunacy rate (2·4), with an increase of population rather below the average (11·3), and also slightly below (18 per cent.) the number accounted for by the births. The fourth, or Eastern Division, comprising Essex, Suffolk, and Norfolk, has a high lunacy rate (2·5) with a decennial increase (6·6), only half the average of England, and about half the number of persons (48 per cent.) who

TABLE III.

Registration Divisions.	Population.	Lunatics.	Lunatics per 1000 of Population.	Increase of Population 1861—71 Per cent.	Per centage Real Increase over or under Natural Increase.	Paupers per 1000 of Population.	Persons per square mile.
1. London—Metropolitan Middlesex, Surrey, and Kent.	3,251,804	9094	2·8	16	+35	47	26,682
2. South Eastern Extra-Metropolitan Surrey and Kent, Sussex, Hants, and Berks.	2,166,217	5428	2·5	17	+22	53	341
3. South Midland Extra-Metropolitan Middlesex, Herts, Bucks, Oxford, Northampton, Hunts, Beds, and Cambridge.	1,442,567	3421	2·4	11	—18	63	288
4. Eastern—Essex, Suffolk, Norfolk.	1,218,257	3005	2·5	6·5	—48	71	243
5. South Western Wilts, Dorset, Devon, Cornwall, and Somerset.	1,879,898	4572	2·4	2·5	—80	66	241
6. West Midland Gloucester, Hereford, Salop, Stafford, Worcester, and Warwick.	2,720,003	6439	2·4	11	—26	44	442
7. North Midland Leicester, Rutland, Lincoln, Notts, and Derby.	1,406,823	3106	2·2	9	—35	44	354
8. North Western Cheshire and Lancashire.	3,382,590	6497	2	15	+24	32	1,082
9. York—Yorkshire.	2,395,299	3662	1·5	19	+33	33	419
10. Northern—Durham, Northumberland, Cumberland, and Westmorland.	1,414,066	2260	1·6	23	+32	40	259
11. Welsh—Monmouth and Wales.	1,426,584	3153	2·2	9·5	—29	64	178

formed the excess of births over the deaths had gone away. Coming to the South Western Division, which comprises Wilts, Dorset, Devon, Cornwall, and Somerset, we find still a high lunacy rate (2·4), a very small decennial increase (2·4), and 80 per cent. of the natural increase gone away. The West Midland Division, comprising Gloucester, Hereford, Salop, Stafford, Worcester, and Warwick, shows a lunacy rate above the average (2·4), an increase of population slightly below the average, and 26 per cent. of diminution of the excess of births. The North Midland Division (Leicester, Rutland, Lincoln, Notts, and Derby) is the first where we find the average lunacy rate (2·2). It has an increase of population below the average (9), and has lost 35 per cent. of its natural increase by emigration. The next three divisions, North Western (Cheshire and Lancashire), York (Yorkshire), and the Northern (Durham, Northumberland, Cumberland, and Westmorland) all show the same characteristics, viz., a lunacy rate much under the average (2, 1·5, and 1·6 respectively), an increase of population over the average (15, 19, and 23), and a large gain by immigration over the natural increase (24, 33, and 32 per cent.) The last division, the Welsh (Monmouth and Wales), has the average lunacy rate (2·2), an increase of population below the average (9·7), and a loss of its natural increase to the extent of 29 per cent.

These divisions being large, unequal in size, and many of them embracing counties and districts entirely diverse in regard to the occupations and circumstances and increase of the population, and arranged on no special plan, except contiguity and convenience of grouping, an examination of their lunacy rate and its relation to the increase of population is, in many respects, unsatisfactory. Its chief value lies in correcting the local idiosyncrasies of small counties by its larger grouping, and in the real similarity of a large number of the counties included in many of them. Certainly the London, South Midland, Eastern, South Western, North Western, York, and, to some extent, the Northern and Welsh divisions, have each distinctive and specific natural features, and, taking those divisions, their lunacy rate, their increase of population, and the extent to which this latter is accounted for by the excess of births over deaths, have definite relations. In the London Division there are causes which make the first exceed the ratio of the two others, and make them all to be above the average. In all the other divisions named the lunacy rate stands in inverse ratio to the two others, being high where they are low, and low where they are high.

Indeed this rule applies, more or less, in them all, except in the case of the metropolis and the adjacent counties.

The close connection between a rapidly increasing population and a small number of the insane being thus established in regard to by far the greater part of England, the next important point to be investigated is whether the increase of lunacy in any way corresponds with the decennial increase of the population in the various counties of England. This is a point which is by no means capable of such a satisfactory investigation as the preceding. The increase of the population in each county is a definite fact capable of absolute proof, explain it how we may ; while the increase of lunacy in any county is a fact influenced variously by many circumstances. The presence of lunatic asylums and how long these have been in existence, their accessibility, the size of the unions, and the state of law, all these, as we shall see, influence it in the most material way. And in regard to the mere definition by the union medical officers of what constitutes an insane or imbecile person, and their enumeration, therefore, in their returns, we have a source of fallacy in comparing one county with another. A harmless simpleton might well wander about a country district and receive relief as an ordinary pauper who, in a more frequented locality, would certainly be put down among the list of lunatics.

Keeping these things in mind, we may now examine the facts as we find them recorded. In the year 1861 there were 35,709 pauper lunatics in England and Wales known to the Commissioners in Lunacy, and in the year 1871 there were 50,637, or a decennial increase of 41 per cent., and this increase has, on the whole, been a steady one from year to year. This is just about three times the increase of the population in that time, which we have seen was 13 per cent. Of course no one believes that lunacy has really increased during that time to that extent ; but it might naturally be supposed that in the counties which have been increasing rapidly in population for a long time by immigration, if the tendency to the production of insanity was very much the same everywhere, the lunacy would be increasing in a greater ratio than in the rest of the country. It might be thought that in those places the newly arrived population would be all healthy at first, but in time would become subject to insanity as to other diseases. If this were so the numbers of insane in those counties would certainly show a far greater rate of increase than in those with no immigration. We shall see if this is the case.

I have not been able to procure correct returns of the actual number of the insane in each county in 1861, and very reliable returns are not to be got until the beginning of 1869. I have therefore taken the numbers of the insane in most of the counties at that time, and then at the beginning of 1872,* and have calculated the yearly increase at that rate. In some respects it is unsatisfactory to have so few years, and in others not so, for unquestionably of late the actual numbers of the insane and imbecile are better returned to the Poor Law Board and Commissioners, there being less obvious irregularity between the percentage different counties in that respect lately. The yearly increase of lunacy in all England for the last three years has been 3·6. I have shown the results in the 4th column of Table II. From that it can be seen that while the majority of the English counties that stood in the first class with low lunacy rates and a rapidly increasing population, are also found to have a rate of increase of lunacy above the average, yet this is not nearly in proportion to the rate of increase of the population. Durham, Stafford, Yorkshire, Lancashire, Surrey, Sussex, and Essex are yearly increasing in their number of lunatics to an extent considerably above the average, but on the other hand so are Beds, Herts, Hants, Salop, Leicester, Devon, Somerset, Oxford, and Berks. Durham increases at nearly thrice the average rate of England generally, while its lunacy only increases about a half more. Yorkshire and Lancashire increase in lunacy at about the same proportional rate as in population. The population of Glamorgan grows at twice the average rate, while its lunatics increase at only the average rate. A large number of the agricultural counties certainly show low rates of increase of both population and lunacy, such as Lincoln, Cambridge, Dorset, Northampton, Nottingham, Norfolk, Gloucester, and Wilts. Taking the counties of England throughout, there is no doubt that the rate of increase of lunacy corresponds in some slight degree to that of population, but the exceptions are so very numerous and striking that this cannot be laid down as a rule. The apparently enormous increase of lunacy in the metropolitan counties in the last three years is well known to have greatly resulted from the opening of the new asylums for imbeciles at Caterham and Leavesden.

Of the group of nine counties in the first class, with little lunacy and a fast-increasing population, in Table II., the rate

* In the case of the Metropolitan Counties, and certain others which had some of their lunatics scattered in asylums elsewhere, I cannot get quite accurate returns from the 1st January, 1869.

of increase of lunacy is above the average in five and below it in four. Of the 14 counties in the second or average class, in which it could be ascertained, seven were increasing above the average, seven below it; and of the 16 in the third, or high lunacy counties, in which it could be ascertained, eight were producing fresh lunacy every year above the average rate and eight below it. This shows how little the yearly increase of lunacy follows the yearly increase of the population in every district. The general average of the rate of increase for each class of counties taken together show 4·4 per cent. a-year as compared with 1·7 for the general population in the first class, 3·8 as compared with 1·3 in the second class, and 3 as compared with ·9 in the third class. (See Table II.)

2. *The Local Distribution of Insanity, in relation to the Pauperism and Wealth of the Counties of England and Wales.*

Pauperism.—In the beginning of the year 1871 there were 1,085,661 paupers in England and Wales, which was at the rate of 47·8 for each 1000 of the population. Still counting Glamorgan separate from the rest of Wales, we find that there were 15 of the 44 counties under this average (Table II.), while the other 29 are above it. We saw, in regard to the lunacy rate, there were 18 counties below the average and 26 above it; and when we examine the two lists a still stronger relationship than this close approximation of the numbers is found to exist; for 11 of the 15 with a low pauperism stand also in the list with a lunacy rate below the average. (See Table IV.) And these 11 counties contain a population of nine millions.

TABLE IV.

	No. of Counties.	Of which Pauperism was under Average in	Of which Pauperism was over Average in	Of which Taxable Property was over Average per Person in	Of which Taxable Property was under Average per Person in
First Class. Lunacy under average.	9	7	2	1	8
Second Class. Lunacy average.	16	5	11	5	11
Third Class. Lunacy above average.	19.	3	16	5	14
Totals.	44	15	29	11	33

Taking the three classes of counties (Table II.) as our basis, and examining them in regard to their proportion of pauperism, this is the result:—Of the 9 below average in regard to lunacy, 7 are below average in regard to pauperism. Of the 16 average in regard to the former, 5 were over average and 11 under in regard to the latter; and of the 19 above average in regard to the former 16 are above average in regard to the latter. These results are shown in Table IV. The very closest approximation, therefore, may be said to exist between the local distribution of the pauper lunacy and the ordinary pauperism of the country, looking at the counties generally; and if we proceed to examine the list still more minutely with reference to each county, we shall still find that this parallelism shows itself in a remarkable manner. Strange as it may appear, the one being a disease incidental to all human beings, and the other a mere result of social and economic causes, the range above and below the average of the rate of pauperism is almost exactly the same as that of the lunacy rate, in both cases going up about 63 per cent. above it, and falling to 41 per cent. below it in different counties. The one ranges from 47·8 per 1,000 (the average) up to 77·2 (Wilts), and down to 28·1 (York, North Riding) per 1,000, the other from 2·2 (the average) up to 3·6 and down to 1·3.

The great exceptions to the general rule in regard to the connection between the lunacy rate and the increase of population, which we saw to exist in the metropolitan and rural Welsh and certain other counties, do not exist in regard to the rate of pauperism; and the existence of a few individual exceptions, such as Essex, Cambridge, and Suffolk, which have comparatively low lunacy rates and high rates of pauperism, on the one hand, and Leicester, Worcester, and Salop, which are high in lunacy and about average in pauperism, does not invalidate a rule so generally applicable throughout England. Where a fact such as the unequal distribution of lunacy is dependent on many causes, and has relations to many natural and social phenomena in a diversified country like England, it never can run quite parallel to anything else.

The general correspondence of lunacy and pauperism appears in the registration divisions of England (Table III), as well as in the counties, and they follow each other closely, or not, in precisely the degree to which each division represents a homogeneous group of counties; the Metropolis

as usual forming an exception to all rules in regard to its lunacy rate. All the divisions which are above the average in regard to lunacy are also above the average in respect to pauperism, with the exceptions of the Metropolitan and West Midland.

Wealth.—When we come to examine the wealth of the various counties of England in relation to the pauper lunacy of those counties, we are met at the outset with a radical difficulty in the utterly unequal distribution of that wealth among different classes of the population. If we take all the taxable property as assessed under schedules A, B, and D, and calculate its amount per person of the population in the various counties, we see at once how little this represents the wealth that is generally distributed among the people. The richest counties in England show the least amount per head of the people, while some of the poorest show the greatest amount. The average for all England and Wales for the year 1870 was £13 15s. per head, and when we find Yorkshire, Durham, Glamorgan, Chester, Kent, and Surrey below this average, while Somerset, Wilts, Huntingdon, and Rutland are far above it (Table II), we see that this is an incorrect test of the wealth of the people. Of the nine counties at the head of the list, whose united population is increasing so enormously, only one shows a rate of taxable wealth above the average.

But when we come to apply the test of what we know to be the real wealth, or rather the ordinary rate of wages paid to the labouring classes in the various counties of England to the rate of lunacy of such counties, we see at once how close is the relationship. In all the Northern Counties the rate of wages is good, and in them all, whether agricultural or manufacturing, the rate of lunacy is low. The Eastern Counties of Lincoln and Essex, where wages are good are also low, while the Southern and Midland Counties of Dorset, Somerset, Wilts, Gloucester, Worcester, Oxford, Hereford, and Berks, where the wages are very low, produce far above the average amount of lunacy. Taking for comparison two parts of the same county differently situated, in regard to wages, the poor man's wealth, viz., rural Gloucestershire and Bristol, we find that while rural Gloucestershire with its labourers, too poor even to go where they could get double wages, except through Canon Girdlestone's charity, produces insanity at the rate of 3·3 per 1000 of its population, rich Bristol has only a rate of 1·7 per 1000, or about

one half as much. To show that this is not owing to mere employment, or the influence of town life, let us look at Newcastle as compared with rural Northumberland. There we know the agricultural labourers are better off and more comfortable, and get better wages than their class in any part of England. Newcastle had a population of 128,160 at the census of 1871 with 274 lunatics at that time, or at the rate of 2·2 per 1000. The rest of Northumberland had a population of 258,799 with 472 lunatics, or only at the rate of 1·9 per 1000. As might naturally have been expected the country shows itself more healthy than the town as regards even the production of insanity, other things being equal, and no doubt the chief of all those other things are good wages received by the labouring population, and all that they imply.

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