Neuritis

A Clinical & Pathological Study

by

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A CLINICAL AND PATHOLOGICAL STUDY

The cases recorded in the clinical section of this thesis, came under the observation of the writer, while acting as house physician to Dr John Lindsay Steven in the Glasgow Royal Infirmary. They comprise all the cases of definite disease of the peripheral nerves, out of a total of over three hundred patients, suffering from general medical disorders. The number of cases is too small to allow of any generalisations, and the plan adopted has been to make a separate study of each case , with special reference to any uncommon phenomena. The observations recorded, except where another's name is mentioned, were made by the writer and embodied in his reports in the journals of the wards, while some of the patients were afterwards seen at their own homes. Dr Lindsay Steven kindly gave permission to make use of the reports, which were primarily written for him.

In the pathological section no original work is

recorded, and the writer merely offers a digest of his reading, undertaken for the purpose of gaining a standing ground of ascertained facts, an appreciation of some of the theories which have proved true guides, and a glimpse down some of the paths, which the various pioneers are investigating, in the general search for truth. Short sections on the anatomy and physiology of nerves have been included, for the purpose of defining terms, and of indicating the basis upon which the pathology rests.

CASE I Multiple Peripheral Neuritis of Alcoholic Origin & (Polyneuritic Psychosis)

P.G. aged 49 was admitted on the 11th November 1905

Complaint - Loss of power of the legs and general weakness, of three months' duration.

History of the illness. Up till three months ago, the patient says, he enjoyed very good health and was quite fit for his duties. The first feeling of weakness was in his legs, which seemed benumbed, and as if "asleep". Previous to this he could walk all day, and, indeed, his work compelled him to go about all the time. He now found that he had to sit down every few minutes, on account of the excessive weakness. He never tumbled down, though he often staggered, and with this there was great general weakness. His appetite has failed very much, and he has vomited a good deal. His eyesight has become defective during the last three months; for some weeks also he has had some singing in his ears.

His wife, on being questioned, confirms most of these statements as to the course of his illness, but says that for the past eighteen months, he has indulged very freely in alcohol, and has thereby lost one situation after an-

other. Previously he had been very abstemious, and had been in a good social position. No history of excessive smoking is obtained.

Previous Health There is no history of any former illnesses: he never had any epileptic convulsion.

Family History - unimportant

Present Condition 12/11/05 Temp.98 Pulse 84 Resp.26 The patient lies on his back, breathing easily; he has a look of weariness. The face is pale: the eyes lack lustre and the conjunctivae are a little congested. The lips are pale and bluish; the tongue is clean and not tremulous. The extremities are blue and cold. The patient looks more than his age.

The Mental Condition is weak. He complains in a whining tone of his misfortunes, and describes himself as a most exemplary person. Many of his statements are quite obviously fabrications, e.g.he says that up till the day before admission, he was working as a contractor's foreman and earning 25/- a week, whereas his wife assures us, that he has only had casual employment in the last year, and lately has not been fit for work. In reply to many questions

about recent events, the patient's answer is "I don't remember".

The Legs There is a reddish mottling of the skin at the ankles, as if from venous stasis in the small vessels, and there are some varicose veins. There is great weakness of all the muscles of both legs, but no absolute paralysis is made out. Possibly the weakest group is that of the peroneal extensors on the left side, where there is a certain amount of foot drop. The walking power is very poor. The legs are stiff and can hardly be raised from the ground, being dragged along. The body is bent and the knees are kept far apart, so as to assist in maintaining balance, but even with that, the patient is glad to assist himself by grasping at any support. He cannot raise himself on his toes. The knee-jerk is absent on both sides. Ankle clonus is not obtained. The legs are drawn up on plantar stimulation. Babinski's sign is not present. The cremasteric reflex is present.

Sensation Great diminution in tactile sensation is found, from the feet right up to the level of the xiphoid cartilage. The loss of feeling is most absolute in the legs.

In the same area the sense of pain, and of heat and cold, is practically gone. It is gradually regained as one passes upwards on the abdomen and back of the trunk. There does not seem to be any loss of muscular sense.

The Arms The muscular power is deficient, but not to anything like the extent seen in the legs. The dynamometer with the right hand registers 10 kilos, with the left hand 15 kilos. No loss of sensation is made out, and the patient can write well.

The Eyes The visual acuity of the right eye is 6-60ths; with the left eye none of the types can be read, and fingers can scarcely be counted. The pupils are contracted; they respond to light and in accomodation. There is partial ptosis; the eyelids can be lifted for a few seconds, but are soon allowed to drop again from weakness. Ophthalmoscopic examination reveals nothing abnormal in either fundus.

The Ears The patient complains of buzzing, which he says has been present for some weeks. He hears a watch at a distance of 1" from the left ear, but only on contact with the right.

Circulatory System No apex beat is seen or felt The right border of cardiac dulness is ½" to the lefty, and the left border 3½" to the left of the middle line, the upper border is in the 4th space. On auscultation the point of greatest intensity of the first sound is in the 5th space 3½" to the left. The sounds are pure and of fair quality at the apex, but very faint in the aortic area. The pulse numbers 84, is small, regular, and very compressible.

Respiratory System The thorax bulges somewhat on front. A good percussion note is obtained all over. On auscultation on front, expiration is found to be prolonged and to be accompanied by rhonchi. On both sides behind, the respiratory murmur is very feeble, and prolongation of expiration is still detectable.

The Abdomen is moderately distended and tympanitic. The hepatic dulness measures 3¼" in the mid-clavicular line. The splenic dulness is not enlarged.

The Urine is amber, acid, spgr. 1020, has a deposit of urates, contains no albumen, blood, bile or sugar.

On the day of admission and again three days later, the patient was seized with an epileptic convulsion. In the

second (in which he was seen by the writer) the clonic spasm chiefly affected the face, and lasted about two minutes; unconsciousness continued for about fifteen minutes.

Progress of the Case 23/11/05 A good deal of improvement has taken place in this patient's condition. He feels better generally, and the pulse is stronger. He still complains of pain in the calves of both legs, which are tender to pressure. The walking power is better and the general condition of the muscles firmer. On testing sensation, it is found to be quite accurate and acute above the knees; from there downwards on both sides it is less so, especially in the ankles and feet. A fairly light touch can, however, be appreciated in most places. He is unable to distinguish a pin-prick as such below the knees, and feels no pain from this. It is not possile to relate the anaesthesia to the anatomical distribution of nerves. The knee-jerks are still absent; the plantar reflex is normal.

19/12/05 The walking power has gradually improved, but there is still considerable stiffness and loss of spring in the legs; he can, however, raise himself on his toes. The pain on pressure still continues in the calves of the legs.

The patient leaves hospital today.

Two months later the patient died at home. No record has been obtained of the terminal phenomena.

Comments on Case I

We are dealing here, not merely with a case of multiple neuritis, but of chronic alcoholic intoxication, affecting many of the organs of the body. The loss of appetite and vomiting betoken gastric catarrh: the blue lips, cold and livid extremities, feeble heart's sounds, and weak pulse give unmistakable evidence of implication of the circulatory system; while in the nervous system, the functions of the brain and special senses are impaired, as well as those of the peripheral nerves.

The impairment of motor power did not proceed beyond paresis, there being no absolute paralysis of any muscle and no deformity. The typical conditions of ankle-drop and wrist-drop had not been reached, but the tottering and shuffling gait, showed how marked was the muscular weakness. The loss of spring in the foot, preventing the patient's raising himself on his toes, is a point on which Ross* laid great stress, and it is noteworthy that the pat-

* Ross and Bury "A Treatise on Peripheral Neuritis" 1893 page 110

ient regained this power while in hospital. The partial ptosis, indicating weakness of the third nerve, shows the wide extent of the motor paresis.

There is nothing absolutely distinctive of peripheral neuritis in this generalised paresis of muscles. Such a condition might occur in a wasting disease of almost any origin, or be the result of chronic poliomyelitis, and it is the conjunction of this condition with the sensory and psychical symptoms, that gives that clinical entity, which pathological investigation has shown to be due to multiple peripheral neuritis.

The initial numbness, ~~followed by~~ *the subsequent* superficial anaesthesia, ~~with~~ *and the* tenderness of the muscles and nerves, form a characteristic group of symptoms. Spontaneous pain which is commonly found , was not present in this case. The extension of the anaesthesia to the trunk, without loss of sensation in the arms, is unusual, but it is to be noted, that rapidly under treatment the anaesthetic area became limited to a region below the knees, and continued definitely so till the patient left hospital. With regard to the nature of the anaesthesia, the weak intellectual condition of the

patient made it impossible to base too much faith on his statements, but its distribution could not be related to the course of definite sensory nerves. Starr* in his recent work says: "The distribution of the anaesthesia, when it is fully developed, corresponds to the parts of the extremities covered by gloves and stockings, and hence has been named the glove-shaped and stocking-shaped area of anaesthesia.....This distribution is quite diagnostic of multiple neuritis".

The implication of the special senses is a somewhat rare complication of alcoholic neuritis. The condition in the eyes was, presumably, a toxic amblyopia, nothing having been observed to account otherwise, for the marked diminution in visual acuity. No history of over-indulgence in the use of tobacco was obtained, and Swanzy** assures us, "that cases of pure alcohol-amblyopia certainly do occur". The affection seems to be a retrobulbar neuritis.

Whether the buzzing in the ears and deafness were due to a similar affection of the auditory nerve or not, it is difficult to determine.

* M. Allen Starr — Organic Nervous Diseases — 1904 — page 104

** Henry R Swanzy — Handbook of Diseases of the Eye — 1900 — page 465

Psychical Condition The higher mental faculties of this patient had all become degenerate. The will, instead of regulating his behaviour, was subservient to a desire to satisfy his creature comforts, and thus in his relations with the other patients, he betrayed the utmost selfishness and lack of consideration. Manliness and independence of mind were gone, while his fearfulness and whimpering speech were rather ludricous. On some subjects he could converse freely, but his memory in regard to recent events was defective. This amnesia is characteristic of alcoholic dementia.* Loss of moral fibre was seen in his telling lies, while endeavouring to screen himself after various breaches of ward discipline.

The occurrence of epileptic convulsions, the first that he had had, is interesting, in that it shows how this affection may supervene, at a fairly advanced age, in those whose nervous systems have become degenerate. Such a complication is not common, but casual references are found regarding it in various writers.†† Cagney,‡ approaching the subject in the opposite direction, discusses the superven-

* Ross and Burry Loc. cit. page 168
J. J. Clouston Clinical Lectures on Mental Diseases 1898 P. 490
†† F. W. Mott "The Diagnosis of General Paralysis" "Practitioner" Jany 1898 P. 17
‡ Jas Cagney "On the Recognition of Peripheral Neuritis, and some Points in its Treatment" "Lancet" 17th Augt 1895

-tion of multiple neuritis in patients suffering from epilepsy and other neuroses.

The treatment in this case was directed to the general condition. The patient was kept at rest in bed, was given light ordinary diet, and Easton's Syrup was administered. Under these conditions he improved considerably, but the fatal termination soon after leaving the Infirmary is not surprising, in view of the grave indications in the various systems.

CACE II Alcoholic Neuritis

of Unusual Type

Mrs P. aged 34, housewife, was admitted on the 10th January 1906

Complaint - Pain in the feet and legs, especially the right, of five weeks' duration.

History of the Illness The patient's sixth child was born two years ago, since when she has not been well, her chief trouble being weakness, nervousness, and pain in the back. Frequently during the night she had cramps, especially in the soles of her feet, and she had various disturbances of sensation, such as prinkling and formication in her legs. These always disappeared on rubbing. If she went out she could not walk far, on account of severe pain in the back. One day about five weeks ago, she got a chill while washing. During the night she awoke feeling pain in both legs from the knees downwards, especially in the right. When she got up out of bed she fell, "having no power in her legs": she found also that she had no feeling in her legs, and she proved this by getting her husband to stick a needle into them. She put her feet into hot water, with the object of relieving the pain, and she found when she

took them out, that the right was blistered, although she had not been aware that the water was too hot. Swelling commenced at once, and extended from the toes to the knees. Severe pain continued, especially on the right side, and this has persisted. It is of a sharp, darting character, passing upwards from the toes at intervals of a few minutes during the night. As a result she has been able to get to get very little sleep. Sensation has gradually returned to the feet and legs, especially to the left.

Previous Health. Seven years ago, she says, she had an attack of acute Bright's disease followed by gall-stones. Since then she has suffered from severe pain of a colicky character. Her medical attendant at times injected morphia for the pain, but about two years ago, she began to take laudanum and whisky on her own account to obtain relief. Since then she has continued the habit of taking these drugs. She used to take twenty-five drops of laud-anum and half a glass of whisky at a time. Over two months ago, she says that she determined to break herself of the habit, and that since then she has taken none.

Social Conditions. She stays in a room and kitchen house with her husband and five of a family.

Family History - unimportant

Present Condition 11/1/06 Temp 98.2 Pulse 104 Resp 20. The patient lies easily in bed. From time to time it is seen that she is suffering attacks of pain. The face is somewhat bloated. The colour of the mucous membranes is good. The pupils are dilated, they respond to light and in accomodation. The tongue is large, flabby, tremulous, and slightly furred. The patient is of a stout habit of body.

The Legs There is no apparent atrophy or swelling, and the condition of the skin is good, except that on the right foot, there are the remains of the blisters mentioned above. The right foot and leg are the seat of severe pain, and there is tenderness along the course of the posterior tibial nerve. On deep pressure of the sciatic nerve tenderness is also elicited. On the left side there is no pain, but there is tenderness of the calf muscles. All muscular movements are carried out fairly well, and it cannot be said that there is any paralysis. Common , temperature, and painful sensations are acute and accurate, in both feet and legs. The only sluggish part is the sole of the right foot. Both knee-jerks are exaggerated; ankle clonus is not

obtained, but patellar clonus on the right side is found. The plantar reflex is normal on the left side, and absent on the right.

The Heart The apex beat is in the 5th space, 4" to the left; the cardiac dulness extends from 1" to the left to 4" to the left of the middle line. The sounds are pure and of fair quality. The pulse numbers 104 is small, regular, and of rather low tension.

The lungs, abdominal organs, and urine present normal characters. Pelvic examination reveals nothing abnormal in the uterus and appendages

The Electrical Reactions are normal as regards quality, there being a fair response to faradic stimulation, but the ~~legs~~ muscles of the legs require a much stronger current than those of the arms, to produce a contraction.

Progress while in Hospital The patient was under observation for six weeks. The acute tenderness of the muscles and nerves disappeared gradually, especially from the left which became quite well. Attacks of pain in the right foot continued to trouble her, so that even when she left she could not put her weight on it in walking. A complaint

of a feeling of pins and needles in her hands and arms in the mornings, suggested an extension of the affection, but nothing more definite developed there. On the whole the improvement in the patient's condition was marked.

Condition a year and a half later 21/3/07 The patient was seen today. She has quite evidently kept up her habit of secret drinking, and a striking deterioration of her mental qualities has resulted. Her house and personal condition betoken the utmost negligence. She is very lachrymose, bemoaning her hard fate, blaming others for it, and being unwilling to attribute it to the whisky, which she acknowledges that she takes. She has delusions of having been robbed of ℔ £500 (quite a small matter, she explains) and of being persecuted by her neighbours. Many of her statements are obviously at variance with the truth, and indeed, one feels that anything that she says, is more likely to be false than true.

She says that she has now no pain, and on the contrary has no feeling in her right foot and leg. On examination she is found to have loss of sensation to light touch, and to pain, from the toes to somewhat above the knee. The

anaesthetic area is of the"stocking-leg" variety, not following the anatomical distribution of nerves. A deep prick with a pin is felt as a light touch, and firm, deep pressure on the muscles results in a sensation of needles and pins, running down to the foot. The nutrition of the limb is good, and there is no appearance of trophic changes. In walking she halts a little on this foot, but does not drag the toes. There is no paralysis of any of the leg muscles. The patellar reflex is still very active; the plantar reflex is absent; there is no ankle clonus.

The left leg is normal.

She says that at times she loses the power of her hands and drops articles, which she has lifted. There is no appearance of wasting or paralysis of the arms.

COMMENTS ON CASE II

The early occurrence of cramps in the soles of the feet, is a significant fact, which merits some consideration, both on account of the appearance of these , long prior to the time, at which the patient realised that she was ill, and by reason of the interesting pathological questions, which they suggest. They had troubled the patient

during the night for two years. Cramps, of course, are not rare phenomena, but their causation and significance, have not been satisfactorily explained. Their onset after prolonged exertion suggests a spasm due to tiring of the nerves or, possibly, to an accumulation of waste products: they are also found in advanced arterio-sclerosis, where they may be in line with the spasms of angina pectoris: and their association with gastric disorder (acidity, flatulence etc.) is well known, and this may have been present in the above case. But the occurrence of cramps as an early symptom of peripheral neuritis, was specially referred to by Ross,* who considered them a sign of motor irritation. He says that they most commonly affect the calf muscles, though those of the forearm and hands are not exempt, and adds: "It is curious to notice how little attention these cramps have attracted, considering that they are seldom altogether absent, and that, in the majority of cases, they distress the patient for years before the paralysis declares itself". It would, therefore, seem, that we have in cramps a suggestive indication, pointing to the peripheral nerves, at a period long prior

* Ross and Bury Loc cit page 153

to the onset of more clamant symptoms.

The pathological question, which presents itself is: Do these preliminary cramps represent irritative changes in the peripheral nerves? The whole subject of "Spasm" was investigated by Dr Seymour Sharkey*, who says that though reflex spasm no doubt occurs, "it is difficult to decide how far the afferent or efferent nerves, or the nerve centres take the leading part in its production". Dr Judson Bury†† goes further than this, and in his classification of multiple neuritis, speaks of a definite "spasmodic" variety. In support of this, he sets forth numerous phenomena as evidence, which give good ground for believing, that early cramps do indicate a commencing lesion of the peripheral nerves.

In the above case the motor disturbances never proceeded to actual paralysis; the patient's statement, that during the acute pain, "she had no power in her legs", cannot be taken literally; certainly in hospital she did not exhibit anything beyond a slight paresis, with little or no atrophy. This leads to a consideration of the fact,

* Seymour J. Sharkey Art. on "Tremor, Tendon Phenomena & Spasm" in Allbutt's System of Medicine 1st Edn. Vol VI p.537

†† Judson S. Bury Art. on "Multiple Symmetrical Peripheral Neuritis" in Allbutt's System of Medicine 1st Edn Vol VI p.689

that the knee-jerks were more or less exaggerated, during all the time that she was under observation in hospital, and also when seen again a year and a half later. Absence of the knee-jerk is considered a cardinal sign in multiple neuritis; the possibility of its being retained has been denied by some observers, others say that they have never seen it, while a few record the fact. Ross* in an analysis of 77 cases, found that it was lively in five and normal in one, and that in the others, it was absent during the whole or part of the time. It should be said, that the exceedingly active state of the tendons in this patient, at first seemed to throw doubt on the correctness of the diagnosis, but the subsequent history set the matter at rest. Ankle clonus was not obtained, but patellar clonus was on several occasions. The myotatic irriability was thus normal or increased, throughout the whole course of the illness. That this should have been so during the early stage would not have been so remarkable, but the continuance of this condition after the anaesthesia had become marked, is quite anomalous. Head†† has shown that "deep sensibility is due to afferent fibres, which run with the motor nerves, and supply

* Ross and Burry Loc. cit. page 156

†† Henry Head & James Sherren } "The consequences of injury to the Peripheral Nerves in Man" "Brain" Summer Number 1905 page 109

the muscles, tendons, fasciae, and joints". Probably in this case these had escaped, and had provided the sensory portion of the reflex arc for the knee-jerk.

The clinical picture here differs much from the common one. May it not be, however, that just as we have amyotrophic lateral sclerosis, with increase of tendon reflexes, as a variation on the ordinary type of progressive muscular atrophy, so there may be cases of peripheral neuritis, with a certain amount of spasticity? On the other hand, the condition of the tendons in this patient may be unconnected with the neuritis. Dr Parkes Weber* has recently drawn attention to the extent to which increase of jerks, and even clonus, may be present in purely functional disorders.

The sensory nerve fibres in this patient's case were those chiefly affected. To recapitulate, the symptoms were:- prinkling and formication in the legs at an early stage, continuing for some time; acute pain coming on suddenly after a chill, and being accompanied by anaesthesia; persistence of the pains for about three months, during which the anaesthesia disappeared; and later on the supervention

* F Parkes Weber "A Note on Excessive Patellar Reflex of Functional Nervous Origin, and especially the 'Fepidation' or 'Spinal Epilepsy' Form" British Medical Journal 4th Jany 1908

of profound anaesthesia in one leg. This sequence of events is such as has been frequently described, but it is their occurrence with few or no motor disorders, which makes this case remarkable. In this connection we observe a change that has taken place in the conception of the disease under discussion. In looking over the earlier bibliography of the subject, the term "alcoholic paralysis" or "alcoholic paraplegia" is almost constantly used, showing that the prominent clinical feature of the disease, as then recognised, was one which, in the case under discussion, was absent.

It may be worth while to quote here the description of this sensory type given by Pitres and Vaillard,* as the present case seems to coincide very closely with it.

"In some rare circumstances, which appertain specially to alcoholic and tuberculous intoxication, neuritis "seems to limit itself to lesions of the sensory fibres of "the nerves, which it affects. The motor phenomena are insignificant or absent: voluntary motor power is scarcely "affected or normal. Symptomatic manifestations confine themselves to sensory troubles, at least the latter dominate the

* Pitres & Vaillard Art. Névrites et Polynévrites " Traité de Medecine et de Therapeutique Brouardel et Gilbert 1902 p. 90

"picture. They are: formication, numbness, cramps or pain-
ful spasms in the muscles, especially at night, cutaneous
"hyperaesthesia, more or less mixed with anaesthesia, ten-
"derness of the muscles and nerves, sharp, shooting, boring,
"convulsive pains in the nerves, muscles, bones etc. These
"pains may be so intense, that they produce a state of pain-
"ful paraplegia, and by the deprivation of sleep, the con-
"tinuance of suffering leads to wasting. The tendon reflexes
"are often preserved, and the cutaneous reflexes exaggerated"

As regards trophic disturbances, one point calls for special notice, viz., the production of blisters. These were caused on the night of the onset of the acute pain, by the patient putting her feet into hot water, and the remains of them were present at the end of five weeks. The anaesthesia was doubtless the cause, which predisposed to the production of the blisters, and hindered their healing. Similar cases are on record,* where water, seemingly pleasantly warm, has caused burns in anaesthetic limbs.

In view of the continuance of drinking after leaving hospital, a much more rapid extension of the disease might have been expected. But if the advance in the peri-

* Sir Wm. R. Gowers "Manual of Diseases of the Nervous System" 1899 page 79

phery was slow, the brain showed unmistakable signs of the increase of the poisoning. The evidence of uncleanliness, the bursts of passion, alternating with fits of weeping, the grandiose ideas of opulence, coupled with delusions of having been robbed, slandered, and persecuted, betoken a stage in alcoholic insanity, earlier than that of case I, but quite as definite.

The treatment in this case consisted in absolute rest in bed, light ordinary diet, abstinence from alcoholic stimulants, and the administration at first of salicylate of soda. Various sedative liniments were tried for the painful parts (which were kept well protected) and by these measures considerable relief was obtained. At the end of three weeks, the acute pain having subsided, the constant current was commenced, an application of ten minutes being given every second day. Afterwards gentle massage was begun and a general tonic was administered.

ALCOHOL in relation to PERIPHERAL NEURITIS

These cases are believed to be of alcoholic origin. In the first the chief beverage was undoubtedly whisky, though beer cannot be altogether excluded; in the second case whisky was said to be the only form of alcohol imbibed.

Up till 1900 it was generally held, that alcoholic paralysis was confined to spirit drinkers: this view had been accepted for over 100 years, since Lettsom's description in 1789. The Manchester epidemic of arsenical neuritis in beer drinkers (in 1900) threw a new light on the subject of etiology, and the matter was fully discussed at the meeting of the British Medical Association in the following year.

Dr E.S.Reynolds* of Manchester, who had been so successful, with others, in tracing the outbreak to its source, said that he had been sceptical for many years, as to the restriction of peripheral neuritis to spisit drinkers, and that, indeed, he had always obtained a history of beer-drinking as well. After the epidemic broke out, its origin had been traced to arsenic in the beer, which element was also recovered from the hair, skin, etc., of those suffering

*E.S. Reynolds "Peripheral Neuritis in Beer Drinkers"
British Medical Journal 12th Octr 1901
The Lancet 10th August 1901

from the affection. He went on to maintain, that probably arsenic was the chief, or even the actual cause , of the bulk of the cases previously known as "alcoholic neuritis". He also suggested that where an undoubted history of pure spirit drinking was obtained, the whisky might have contained arsenic. His statistics showed, in any case, that since the stoppage of all contaminated beer, the disease had become rare in Manchester, where, in former years, it had been quite common.

Various leading physicians commented on these views, and the general trend of opinion, was against the acceptance of the arsenical theory of alcoholic paralysis.

The opinion of Sir William Gairdner* may well be quoted here. He said that since 1884, when he had seen five or six cases at one time, in the wards of Dr Ross in Manchester, he had been carefully on the outlook for similar cases in Scotland, where, spirit-drinking being so common, one would expect to find well marked examples of alcoholic paralysis. Yet it was safe to say, that the cases he had seen in all these years, if not numbered on the fingers of one hand, would be well within the fingers of his two hands. He believed , therefore, that some kind of localising cause,

* Sir Wm Gairdner Contribution to Discussion B.M.J. 12/10/01

other than alcohol, was evident, such as arsenic in the recent epidemic.

The general outcome of the discussion tends to shake one's faith in the "pure spirit" origin of alcoholic neuritis, and to suggest that there is always another factor in the case, acting either alone, or on nerves previously weakened by excess.

CASE III Tuberculous Neuritis

Mrs M. aged 45, an office cleaner, was admitted on 1st February 1906

Complaint - Pain and weakness of the left leg, of six weeks' duration, with "bronchitis".

History of the Illness. For about two years the patient has been subject to "bronchitis". About seven weeks ago she had an extra bad attack, and had to stop work and remain indoors. About a week later, i.e. about the 16th December, while sitting at the fire, she began to feel a numbness in her left calf, spreading down to the toes. She perceived that sensation was gone on the outer side of this leg, but that it was present on the inside and on the sole. This numbness remained the same for about two hours, when excruciating pain commenced, shooting up from the big toe as far as the ankle, above which the leg seemed to be "sleeping". The patient says that this pain far exceeded any other that she has known, including labour pain. It lasted for about five hours, and was not relieved by hot applications and other remedies. Since then she has always had pain in the same place, but never of anything like the acuteness observed at the onset. At first

no swelling or redness was to be seen, nor did they appear till a fortnight later. On the 24th inst. she came up here and, when seen, it was observed that there was swelling and redness about the ankle, which were so marked as to suggest some acute inflammatory condition, and she was admitted to a surgical ward. With rest the redness and swelling almost disappeared; she continued to have some pain, but went home on the 30th. When she began to go about her house work, the swelling and redness ~~disappeared~~ reappeared, and she had considerable discomfort in walking. Dr J. Wallace Anderson, of Dennistoun, who had previously been in attendance, sent her up ~~here~~ again.

There has never been any special swelling and pain of the great toe; and there has been no pain or other affection of the right leg. The appetite has been poor. The bowels are regular. Menstruation has been irregular in the last six months. The cough has continued to trouble her a good deal. There is a yellowish spit which has occasionally been streaked with blood. She has been feeling less fit for her work since last July. At night she perspires freely.

Previous Health At the age of 32 she had "inflam-

mation of the womb", following the birth of her last child. About five years ago she was subject to "fits", which seem to have been epileptic in nature. These occurred on occasions at the menstrual period, for about a year, but have not troubled her since. Three years ago the patient had enteric fever and was in a Fever Hospital for four weeks.

Social Condition The patient has been a widow for twelve years, and has maintained herself and three of a family. Previously she did washing, but lately has been cleaning a warehouse. She never takes any alcoholic liquours

Family History is unimportant. No tubercular element is found in it .

Present Condition 2nd Feby. Temp 97 Pulse 66 Resp20 The patient lies easily in bed without obvious sign of discomfort. The face is thin but well coloured. The pupils are small: they respond to light and in accomodation. The tongue is moist and clean. The eyes are sunken, and the general condition suggests a wiry habit of body, with some degree of emaciation. There is a slight amount of clubbing of the fingers and curving of the nails. The hands tend to be cold in the mornings, and the patient says

she suffers from "dead fingers".

The Left Leg presents an atrophic appearance as compared with the right, and feels very flabby. There is at present a slight erythema of the skin of the foot and ankle, and when the leg is allowed to hang down, this deepens to a dusky red colour. There is slight swelling about the dorsum of the foot, and the natural hollows about the ankle are filled out. She complains at present of a dull pain on the dorsum of the foot and in the ankle, and there is tenderness on pressure, from the toes to a little above the ankle. There also there is some oedema. The external popliteal nerve can be felt, and does not appear thickened as compared with its fellow on the right side. The measurement at midcalf is 9¾", as against 10½ on the other side.

Motor Power of the left Leg When the patient sits with the limb hanging, it is seen that there is marked foot-drop, and she is quite unable to raise the toes. This can, however, be performed passively without causing any discomfort. Plantar flexion of the toes is readily performed, and the various movements at the knee- joint are

at once carried out.

In Walking the patient lifts the left leg higher than usual, to avoid scraping the toes on the ground. Little weight is put on this foot in walking on account of pain

Sensation (left leg) The knee-jerk is less active than on the right side. The plantar reflex is normal, but not very active. There is marked impairment of common sensation on the dorsum of the foot, from the toes upwards and outwards, and over an area involving the whole outer aspect of the leg, as far as the head of the fibula. The inner margin of this anaesthetic area on front, does not quite reach the tibia, while posteriorly, it extends about halffay across the calf. All the toes are affected, but it is noted that there is better sensation in the second and fifth toes, than in the others. In the sole and elsewhere in the leg, sensation is acute and accurate. Sensations of heat and cold cannot be differentiated over the above area; painful sensations from a needle prick are felt, but are much dulled in comparison with normal.

The Right Leg is normal.

Examination of the Lungs (Dr Lindsay Steven) "Examination of the chest reveals slight relative dulness

"below the right clavicle to the 2nd rib, and to the right "shoulder behind in the supraspinous and interscapular "regions. On auscultation the r.m. over the right front is "more intense and superficial than over the left: no râles "are detected. Posteriorly in the dull area, wheezing râles "observed with prolonged expiration. At the right base post- "eriorly over its whole extent the r.m. is of the bronchial "type, and inspiration is accompanied by numerous, rather "fine, crackling râles. Auscultation over the left back re- "veals practically normal results."

There is a constant cough with a moderate amount of purulent expectoration. Microscopic examination of the sputum shows tubercle bacilli in very large numbers.

The Heart The apex beat is in the 5th space, 3" to the left; at that level the cardiac dulness extends from ¼" to 3½" to the left. The heart's sounds are pure and of good quality. The pulse numbers 66, is small, regular, and of good tension.

Examination of the abdominal organs yields negative results.

Progress in Hospital 17/3/06 During residence the

chief complaint has been of pain, mostly about the great toe of the left foot, so that a sedative has frequently been required at night. The anaesthesia, though much less pronounced, is still present. The muscular power is greater, and the patient can walk better, and can slightly extend the toes. There is a moderate response to Faradic current, showing that there is no reaction of degeneration. Faradism as a therapeutic measure has been commenced, the current being of sufficient strength to cause contraction of the muscles. Cough, with a moderate amount of spit continues. Tubercle bacilli are still fairly abundant, and on one or two occasions the sputum has been blood-tinged. The condition of the lungs does not differ much from that described above.

Condition eighteen Months Later After leaving the Infirmary, the patient went to Bridge of Weir Sanatorium for ten months, during which time her condition improved very much, and she gained two stones in weight. For the first two months she continued to have a good deal of pain in the affected foot, but with the improvement in general health this became much less. The power of the muscles grad-

ually returned, so that at the end of two months she no longer dragged her toes. Dr Guy reports that when she left the Sanatorium "the crepitations had all disappeared from " the right apex, and the quantity of sputum had diminished "from 30 drms. a day in the first week, to 13 drms. a day "in the last week of residence". At present , though not strong she is able for her household duties, and has only a slight cough. She has complete motor power in the left leg and sensation is perfect. At times, however, she feels prinkling in the area previously anaesthetic, and has some pain about the great toe. The nutrition of the skin is good, and there is no erythema.

COMMENTS ON CASE III

In this we have a very perfect example of toxic selection. The nerve affected was the external popliteal, and the various muscles which this nerve supplies were paralysed, while the area of anaesthesia corresponded closely with the anatomical distribution of its sensory filaments, and the vaso-motor phenomena were also definite in the same area. Such selective power of toxins is sufficiently common to pass without further comment here, but, presumably, there

is always a localising cause. No history of strain was obtained, but it is possible that this may have occurred in the course of the patient's arduous daily work. In reference to neuritis of the external popliteal nerve, following strain, Gibson and Fleming* say, "Unquestionally alcoholism renders the nerve in such cases more susceptible to injury". No doubt the same is true of other circulatory toxins.

The vaso-motor phenomena in this case deserve special attention. To summarise, the leading features were:- excruciating pain at first, without apparent change in the limb; continuance of pain , less severe, but increased on walking; the onset of swelling and redness after a fortnight (suggesting gout to one doctor, and an acute pyogenic infection to another); improvement under rest, but recurrence of the redness and swelling, when the leg hung down.

Taken by themselves, these vaso-motor symptoms are typical of that group, which was first described by Weir Mitchell in 1872, and to which in 1878 he gave the name of erythromelalgia. The pathology of this condition has not yet been definitely settled. Anumber of cases have been described, and the striking feature is, that the con-

*Gibson & Fleming Art. on "Diseases of the Spinal Nerves" Allbutt's System of Medicine 1st Edn Vol VII page 667

dition has been found as an accompaniment of a variety of nervous diseases, and that it has also occurred, where no actual lesion could be determined by histological examination. Thus Collier* described ten cases, in which the association was with disseminated sclerosis in six, with tabes dorsalis in two, with myelitis in one, and lastly with ~~x~~ traumatic neurasthenia. It is evident that the mechanism regulating the blood-vessels is at fault, but it has not been found possible to definitely demonstrate the lesion.

The theory, which has received the widest acceptance, is, that a peripheral neuritis is responsible for the condition. Sir Thomas Barlow,** however, while allowing that this may play some part, points out the following objections:- that typical cases show little or no wasting, that reaction of degeneration of the muscles has never been recorded, that of "definite persistent change of sensory function, there is scarcely a trace", and that in cases where nerves have been examined, they have sometimes been found normal.

In the present case it can scarcely be doubted, that the pathological lesion is a neuritis, affecting the vaso-motor fibres. The association with definite paralysis

* Jas. Collier "The Occurrence of Erythromelalgia in Disease of the Spinal Cord" The Lancet Aug 1898

** Sir T. Barlow Art. on "Erythromelalgia" Allbutt System of Medicine 1st Ed. Vol VI p 615

and loss of sensation, is, however, very unusual, and I have been unable to find any parallel case in the literature. A certain amount of vaso-motor paresis, is , of course, a frequent accompaniment of peripheral nerve lesions, but the presence of those three symptoms of pain, flushing, and local fever, increasing when the part hangs down, betokens the clinical entity of erythromelalgia.

Electrical testing of the affected muscles, showed no reaction of degeneration, there being a moderate response to faradism. From the point of view of prognosis, this was favourable, and the subsequent history accorded with the general rule, that such cases improve. The observations recorded, as to the state of the electrical reactions in toxic neuritis, are varied and liable to mislead. Ross's* conclusion was, that "although an electrical examination "may be of use, in forecasting the progress of a more or "less chronic case towards partial or complete recovery, it "is not of much value in judging of the gravity of the symptoms, during the early stages of the disease".

Etiology In this case alcohol could be absolutely excluded. By hard work and thrift the patient had maintained

* Ross and Bury Loc. cit. page 157

herself and her family for many years, and she was, perforce, a total abstainer. Dr J.Wallace Anderson, who sent the patient into hospital, was strongly of opinion that the affection was due to gout; but the association of gout with definite neuritis is so rare, that in view of the discovery of the lung trouble, it may be set aside. The possibility of the enteric fever of three years previous being the cause, has to be taken into consideration, in view of the recent evidence of the continuance of the organism in the body for many years. In this case it seems more reasonable to believe that the cause ~~is~~ was not the previous enteric fever but the present tuberculosis of the lung, and I, therefore, adopt this theory. Careful enquiry as to the various chemical poisons yielded a negative result.

A neuritis of one or many nerves is among the uncommon complications of phthisis or other tubercular infections. In referring to the literature, it is found that the fact of occurrence was first recorded by Joffroy and by Eisenlohr in 1879. In 1886 Pitres and Vaillard reported a number of cases and classified them. Dr C.W.Suckling* was the first to report a case in this country. His patient was al-

*C.W. Suckling "Peripheral Neuritis in Phthisis" British Medical Journal 1887 Vol II p 126

-so a woman with chronic phthisis, and the lesion was very similar to that in the present case, being a peroneal paralysis of strictly anatomical distribution. Recovery under treatment was rapid. In a paper on "Tubercular Neuritis" read before the Edinburgh Medico-Chirurgical Society in 1898 Dr Alex. James* discussed several cases of nerve disturbance due to the tubercular toxin, some of which were definitely peripheral lesions. Starr†† objects to the term "tuberculous" neuritis, because "no one has found tubercles in the nerve trunks in these cases, and bacteriological examination has not demonstrated the presence of bacilli in these nerves". Pitres and Vaillard‡‡ speak with most authority on the subject, and it may be worth while to quote some of their dicta.

"Neuritis is, in reality, very common in the different forms of tuberculosis, and its frequence becomes such "when we look for it systematically, that there is good reas- "on for admitting a causal bond between the specific ill- "ness and the lesion of the nerve cords."....."Commonly it "is indicated by motor, sensory, and trophic disturbances, "isolated and combined. Sometimes muscular atrophy constit- "utes the chief symptom. Sometimes the nervous troubles af-

*Alex James "On Tubercular Neuritis" Scottish Medical & Surgical Journal Vol III 1898

††M. Allen Starr Loc. Cit. page 158

‡‡Pitres & Vaillard Loc. cit. page 43 et ff.

"fect sensation alone, and are manifested by phenomena of "a painful nature and in diverse situations (neuralgia, sev-"ere pain, cutaneous hyperaesthesia etc.) by analgesia, and by anaesthesia".

While recording the views of these writers it must be said that their statement as to the frequency of occurrence is not corroborated by the experience of clinicians in this country.

[illegible] 2nd October, very severe pain [illegible] October, extending to the left side of her [illegible] She remained at work all week, [illegible] On the 8th October she went [illegible] left arm, and when she awoke in the morning she [illegible] do so, and has not had [illegible] was not pain, her left arm more than [illegible] the onset of the actual injury.

Present Condition 18/10/05 Temp 99 [illegible]

CASE IV MONONEURITIS following Strain

M.F. a woman aged 69, unmarried, was admitted on 17th October 1905.

Complaint Weakness of the left arm of a fortnight's duration.

History of Illness. On 30th SEptember the patient was engaged on unusually tiring work, viz., scrubbing the floor of the factory (in which she works) in a room which was exceedingly hot and full of steam. She was engaged at this from six in the morning till eight at night, and on her road home felt perfectly done. Next day she felt stiff and sore, and on 2nd October, very severe pain commenced in her left shoulder, extending to the left side of her neck and to her arm. She remained at work all week, suffering great pain. On the 5th October she went to bed at night able to lift her left arm, and when she awoke in the morning she could not do so, and has not had this power since. She says that she was not using her left arm more than her right, and she knows of no actual injury.

Present Condition 18/10/05 Temp 98 Pulse 88 Resp 20 The patient lies on her right side, breathing easily. The

skin is pale; the pupils are equal and active. The lips are fairly well coloured. The tongue is moist and clean. The general condition suggests a moderate amount of senile degeneration for her age.

The Left Arm is kept close to the side. At the shoulder the roundness of the deltoid (visible on the other side) has given place to an angle, and there is evidently some atrophy. On palpation the left shoulder is found to be colder than the other parts. There is entire paralysis of the left deltoid, so that the patient cannot raise her arm. Passively, it can be stretched above her head, and put in any natural position. The power of the other muscles does not seem to be impaired. No loss of sensation is detected. No tenderness is made out, nor is there any pain at present. Passive movement reveals a little creaking in her left shoulder, but this is more marked on the right side.

Examination of the others organs yields normal results.

An electrical examination of the muscles, shows that in the affected deltoid, the response to the faradic current is diminished, while that following galvanic stim-

ulation is increased (i.e. moderate reaction of degeneration is present.)

Progress 3/11/05 The patient has been getting the constant current for some time, but the condition of the arm has not improved. She leaves today for private reasons.

COMMENTS ON CASE IV

This case clinically is one of deltoid paralysis, presumably due to a lesion of the circumflex nerve. Such cases are common , and arise readily from a fall on the shoulder, or a dislocation of the humerus. In this case there was no history of injury, but the severe work may have produced a condition of strain, leading to an effusion into the sheath of the nerve. This is the theory which seems to the writer most probable. That is to say, that the lesion is interstitial in origin, and the paralysis due to mechanical pressure on the nerve fibres. The rationale of such a condition is discussed in dealing with the next case.

The distribution of the pain over the side of the head, neck, and arm, suggests a certain amount of neuritis about the brachial plexus, but so far as paralysis went, the circumflex nerve alone was involved.

Besides strain, another etiological possibility must be considered - "rheumatism". Acute and sub-acute rheumatism may be set aside in view of the absence of the signs of inflammation. Chronic rheumatism, according to Professor Stockman,* is "an inflammatory hyperplasia of connective tissues in patches", and undoubtedly, this process implicates at times the nerve sheaths. The free movement permitted in the patient's shoulder joint, showed, however, that its ligaments were not inflamed; and the absence of tenderness indicated, that there were none of those fibrous thickenings, on which Dr Stockman lays such stress. But even although the term "rheumatic palsy" were applied to this case, it would not conduct us much further towards a scientific conception of the real cause. Buckley,†† in dealing with the subject of brachial neuritis, gives injury as the most common cause. He finds gout a prominent factor, and thinks that true rheumatism rarely plays any part in the causation. He says: "Such often arise from a chill, especially in a gouty subject, and in the majority of cases, I am inclined to believe, have their origin in a general fibrositis". The confusion which arises here, is due to the fact, that observers

*Ralph Stockman "The Causes, Pathology, and Treatment of Chronic Rheumatism" page 1.

††Chas W. Buckley "Brachial Neuritis" "Lancet" 16th Apl. 1904

are not agreed as to what the word "rheumatism" represents.

It is unfortunate that the patient had to leave the Infirmary before the treatment had been given a sufficient trial. As a rule the prognosis is good in these cases.

[illegible] duration

[illegible] of the disease in [illegible] organ

jumped from his [illegible], [illegible] the room

[illegible]s an hour, and landed on his left foot. There was

[illegible]e ground at the time, and he slipped and fell. He

[illegible]he perceived that he had strained his left [illegible]. It

[illegible] painful. He was able, however, to [illegible]

[illegible] that night, and for a fortnight or three weeks af-

[illegible] all the time he felt pain behind his left knee, no

[illegible] in any direction. This pain became [illegible] worse

[illegible] end of three weeks he stopped work and consulted

[illegible] doctor, who ordered rest. The patient then began to ex-

[illegible] curious sensations in his left leg. He could [illegible]

[illegible], observed and drew his doctor's attention to

[illegible] swelling behind his left knee. Blistering [illegible]

CASE V Chronic Interstitial Neuritis following Injury

J.D. aged 29, a railway guard, was admitted on 1st February 1906

Complaint - Pain and weakness of the left leg, of thirteen months' duration.

History of the Illness In January 1905 the patient one night jumped from his train, which was travelling about five miles an hour, and landed on his left foot. There was ice on the ground at the time, and he slipped and fell; in doing so he perceived that he had strained his left leg, and he felt it painful. He was able, however, to continue at his work that night, and for a fortnight or three weeks after, but all the time he felt pain behind his left knee, not shooting in any direction. This pain became gradually worse, and at the end of three weeks he stopped work and consulted his doctor, who ordered rest. The patient then began to experience curious sensations in his left leg. He also, about this time, observed, and drew his doctor's attention to, a tender swelling behind his left knee. Blistering down the leg was tried, and also the application of a liniment, with-

out much effect. He stayed in bed for a month , and then returned to work. While lying in bed or taking a little exercise, he had not had much discomfort, but when he returned to his employment, and was on his feet all day, the pain again became severe. He continued at work from March till November, suffering more or less pain all the time, especially when he was tired. About the month of June, that is , six months after the accident, he first observed a weakness of the toes of his left foot, so that he could not raise them. To obviate this he got into the way of lifting his knee higher than before, so as to clear the ground in walking; he also had to get into a different way of jumping on to a train, on account of his disability. The pain during this time varied in position, being, at different times, behind the knee, in front of the leg, and on the dorsum of the foot. Sometimes it was dull, sometimes sharp, and it usually shot downwards to the toes. For relief of pain the patient got into the habit of applying blisters.

In the month of November the pain became worse, and the patient stopped work, and was off till the middle of December. The rest did him good, and he returned to work

and continued at it till 31st January, when he was sent up here by Dr Semple Young. The patient thinks that the swelling behind the knee, previously mentioned, is larger now than it was at first. During the whole time the general health has been very good: the right leg has never given any trouble.

Previous Health was good. As a boy he had abscesses in the neck, which discharged for a long time, and the scars of which still remain. He also had an ulcerous condition of his nose, suggesting lupus.

Social Condition The patient stays in a room and kitchen with his wife and three of a family. He very seldom takes any alcohol, and he smokes about two ounces of tobacco per week.

Family History is unimportant.

Present Condition 2/2/06 Temp 97.4 Pulse 70 RESP 20 The patient lies easily in bed. The face presents a healthy appearance, and the general condition is good. The mucous membranes are well coloured; the tongue is moist and clean; the pupils are small and react to light and in accomodation.

The Left Leg feels less firm than the right and on

measurement is 12½" in circumference at mid-calf, as against 13" on the other limb. When the patient sits up with the left leg hanging, marked foot-drop is visible. The nutrition of the skin is all right, and there is no oedema. There is no pain or tenderness on pressure below the knee, but on palpation of the external popliteal nerve, from its origin in the popliteal space to the head of the fibula, it is found to be much thickened and tender to pressure. The patient says that when it is pressed on, he feels pain right down his leg. The size of the nerve now is about that of a man's forefinger, and it forms a distinct bulging of the skin, to which it is not adherent, and it is movable on the underlying structures. On the right leg the external popliteal nerve is easily felt, and seems quite normal. There is at present no other tender spot on the left limb.

Motor Power There seems to be absolute loss of power of the extensors of the foot, and of the peronei, so that dorsi-flexion of the foot is impossible. The plantar flexors of the foot, and the muscles about the knee, have good power

In walking the foot-drop is very markedly seen, and

the leg is lifted high at the knee, so as to clear the ground.

The knee-jerk is very active, as also is the Achilles' tendon jerk. No definite ankle clonus is made out, but there is a suggestion of this. There is no contracture of the Achilles' tendon. The plantar reflex is normal.

Sensation is acute all over the limb, as regards light touch, heat and cold, and pain. The patient says, however, that the feeling on the dorsum of the foot and toes is somewhat "dumb".

The right leg seems quite normal; the knee-jerk here is also active, but rather less so than the left.

The heart, lungs, abdominal organs etc. are normal.

Electrical Tests The reaction of the left leg to electricity is almost nil as regards the affected muscles. There is thus a profound reaction of degeneration (including loss of reaction to galvanic stimulation) in the peroneal muscles of the left leg.

Progress in Hospital 23/3/06 Under massage (directed specially to the affected nerve) and electrical treatment,

the patient has improved slightly as regards power of raising his toes, and has had no pain whatever. He walks about and goes up and down stairs without any discomfort. On pressure of the nerve no pain is elicited, and he says that the sense of numbness has disappeared from the foot and leg. He goes home to continue massage there.

Condition eighteen months Later. He returned to work ten days after leaving the Infirmary in April 1908, and has been steadily at it since then. The foot-drop is now entirely absent. Power has gradually returned to the affected foot and toes, though there is still some weakness. He now walks without much high-stepping, and has a fair amount of spring in his foot. He can dorsi-flex his toes, but cannot fully flex his ankle, and he can raise the outer side of his foot. The external popliteal nerve is now much thinner than before, though very distinctly palpable, being now about the thickness of a lead pencil. Pressure on it causes no pain now. There is no foot-drop, and the patient can run, spring off his foot, and generally do his duties.

Electrical Reactions (tested by Dr James Riddell)

"The extensor communis digitorum responds to strong fara-

"dism, and also to galvanism of 10 mille-amperes, the nat-"ure of the contraction being normal. There is thus no re-"action of degeneration in this muscle now, but merely a dim-"inution of normal excitability. No response to either gal-"vanism or faradism is obtained from the tibialis anticus, "or the extensor hallucis longus".

The peronei were not tested electrically, but the way in which the patient can raise the outer side of his foot, shows that their function is being well performed.

COMMENTS ON CASE V

The outstanding feature of this case, is the slow and insidious march of the symptoms. In summary these were:- a moderate amount of pain in the region of the external popliteal nerve, at the time of the accident: persistence and increase of the pain so as to incapacitate the patient at the end of three weeks; the onset of sensory disturbances (formication, paraesthesia etc.): swelling of the nerve; and in the sixth month paralysis of muscles, still profound at the end of a year.

It may be said at once , that there was probably very little injury to the nerve fibres at the time of the

accident. When a nerve is actually torn or cut, the symptoms are manifest at once, and likewise the results of pressure during sleep or anaesthesia, as a rule, show themselves immediately, and may be of all grades of severity, from mere tingling up to complete loss of function. In the present case however, the symptoms are much more like those resulting from the pressure of a tumour, while crutch palsies have, at times, a similar onset. The presence of an actual new growth of tissue was apparent here: the swelling was observed by the patient at the end of the first month, and had increased when he came under observation at the end of a year.

The pathological section of this paper deals mostly with parenchymatous neuritis, so that it is most convenient to refer here , to the probable organic changes in this case.

It seems likely, that there occurred , as a result of the strain, some bruising within the sheath of the nerve. Following this there would be hyperaemia, effusion of serum, emigration of leucocytes, and possibly some haemorrhage. No swelling or discoloration was observed at the time of the accident, so that we may take it, that any dam-

age outside of the nerve was slight. The normal sequence of events, after an aseptic injury, is, that effused blood, serum, and destroyed cells are removed, with the production of a slight amount of fibrous tissue, which may remain as a tender nodule, giving rise to so-called "rheumatic" pains. But how shall we account for the new formation of tissue, so evident in this patient?

The following possible causes of the swelling may be taken into consideration, in endeavouring to answer this question.

1. A Productive Fibrosis (a) from continuation of the irritation: (b) from an abnormal condition of the blood due to previous tubercular infection: (c) from other idiosyncrasy.

2. A False Neuroma

3 A Stump Neuroma

1 (a) In his classification of chronic inflammations, Professor Adami* employs the terms "replacement-fibrosis" and "productive fibrosis": the former represents that moderate amount of fibrous tissue, following an aseptic w wound, while the latter is a new growth in response to an

* John G Adami Article on "Inflammation" in Allbut & Rollestons System of Medicine 1905 page 796-8

irritant (mechanical, chemical, microbic etc.). Now in the case under consideration, we find that the patient continued at his work on the night of the accident, and for three weeks thereafter. The tendency of this would be to keep up an irritation of the injured part. When such occurs in the case of a broken bone, there is often an enormous formation of callus - a very palpable "productive fibrosis" - and an analagous process may have been at work here.

1 (b) But this patient was himself abnormal, in that he had been the subject of a prolonged tubercular infection as a youth, in testimony to which he bore well marked scars on his neck and nose. The natural reaction of the tissues to the tubercular toxin is a granuloma, and it may be that a person previously infected may continue to react abnormally. I am, however, not aware of definite observations on this matter.

1 (c) Regarding idiosyncrasy, there are some people who have a tendency to fibrous tissue formation after slight injury. To what *extent* this patient may have possessed this quality, it is impossible to say.

2. False Neuroma. The question as to this being

an actual tumour of the nerve, suggests a false neuroma. Histologically,* such is a modification of the connective tissue, originating in the elements of the nerve sheath (endo, peri, or epineurium) and is not a proliferation of nervous elements. Many writers associate the development of solitary false neuromata with definite injuries, bruises etc. But the outstanding feature of these growths, is their benign character as regards the nerve fibres - the rule is, that the latter are simply pushed out of the way, and motor or sensory disturbances are uncommon. This is, of course, in very marked contrast with the baneful influence of the growth, in our patient's case, where function was so markedly interfered with, and we may thus put false neuroma out of our reckoning.

3. Stump Neuroma. The occurrence of swellings on the cut ends of nerves (central and peripheral) is a matter of common observation. I have already stated my opinion, that there was, probably, very little injury to the actual nerve fibres at the time of the accident, or there would have been greater immediate interference with function. But if we allow that there were any fibres ruptured, we intro-

* Alexis Thomson "Neuroma & Neurofibromatosis" 1900 page 176.

duce a new histological element, viz. the neurilemma cells, which have great powers of proliferation, and also the axis cylinders, which have been shown to send out numerous fibrils, in the attempt to restore continuity. In this process we see another explanation of the new growth, but it is impossible to say to what extent it prevailed.

Whatever the exact histology may be, the harm was probably chiefly effected by contraction of the newly formed tissue, after the manner of a scar. The process is probably an extension of the fibrosis to the arterioles and capillaries, leading to loss of the vascular supply of the nerve fibres, and so to their destruction. The interstitial change, in all likelihood, produced a true parenchymatous degeneration, as evidenced by the complete paralysis of the muscles. The first pain at the site of the swelling, was probably due to compression of the nervi nervorum, while the subsequent radiation of the pain down to the foot, betokened implication of the main nerve fibres.

The extent to which degeneration of the nerves had proceeded, may be judged from the fact, that a year after the accident, no response could be obtained from any of the af-

fected muscles. The prognosis was not good, and it was surprising to find, eighteen months afterwards, that foot-drop had disappeared, that the peroneal muscles were acting, and that the extensor communis digitorum was responsive to both faradism and galvanism. The hopeful feature had been the return of sensation, and the improvement bears out strikingly a dictum of Duchenne's, that the ~~xxxxxx~~ prognosis of traumatic paralysis is much more favourable, when, the electro-muscular contractility being extinct, sensibility is unaltered, or but slightly diminished. Bowlby,* speaking on the same subject says, "We cannot say definitely, that this "restoration (of motor function) either will or will not take "place, but I believe we may always say that some improve-"ment will certainly ensue, even though it be after a great "length of time".

The loss of sensation in this patient, did not proceed to any great extent, and a year after the accident no diminution was detectable by the ordinary tests, though he had a feeling of numbness. Here then we have an example of the greater vulnerability of the motor than of the sensory nerve fibres - a fact which has long been recognised, and

*A.A. Bowlby "Injuries & Diseases of Nerves" 1889 page 347 et ff.

regarding which various explanations have been offered. It seems that the sensory nerves have a greater power of resistance, and that, when injured, they possess more abundant recuperative ability than the motor fibres. Fleming* maintains, "that the sensory end organs are known to exert a powerful trophic influence, over the fibres belonging to them". He also believes, that the sensory fibres in the peripheral end of a cut nerve do not degenerate, at least not for a long time. Weir Mitchell suggests, that the constant stimulation of the skin prevents the degeneration, and BOWLby, while countenancing this, supposes that a less perfect condition of nerve fibre may be sufficient for the conveyance of sensation, than is necessary for the excitation of muscular contraction. "Recurrent sensibility" due to ingrowth of fibres from other nerves, or the overlapping in distribution of nerves, has been believed by many to account for the facts. This last idea has been thoroughly investigated by Head,** who shows that, as regards that higher form of sensibility, involving the discrimination of light touch, the appreciation of the finer grades of temperature, and of the points of the compasses (and termed by him "epicritic") there

*Robt. A. Fleming Art. on "Physiology of Nerves" in Clifford Allbutt's System of Medicine 1st Ed.n Vol. VII P. 626

**Henry Head & J. Sherren Loc. Cit. page 184

is no over-lapping, and the anaesthetic area corresponds to the anatomical course of the nerves. Nor does he find that the slow process of recovery is due to the taking up of the lost function by other nerves.

Another point, which has to be remembered in such a case as the above, is, that the muscular tissue itself has to recover from the more or less degenerate state, into which it has deteriorated. Thus, even though the motor fibres had recovered, it might be some time before the muscles regained their function of excitability.

With reference to treatment, it may be said that various counter-irritants were applied, before the patient's admission to hospital. In the ordinary "pressure palsy" these are usually efficacious, but in this case they were not productive of much benefit, except that the use of small blisters relieved the pain temporarily. In hospital the line followed was, that the patient was kept pretty much at rest for six weeks, massage of the limb was given, with special reference to the affected nerve, and the constant current was applied on alternate days. The improvement, though slow, was undoubted.

The question of surgical interference was considered, in view of the good results which sometimes follow it, and if there had been no improvement from the therapeutic measures employed, it might have been called for. Presumably, the line of action, which a surgeon would have taken, would have been to open up the sheath of the nerve, and free the bundles as much as possible from fibrous adhesions. Bowlby,* who discusses the subject thoroughly, says, "It is evi-"dent that when a nerve trunk is more or less compressed by "scar tissue or fixed by adhesions, the mechanical separation "of the nerve is likely to be beneficial, and in this way I "would explain the many recorded improvements, resulting "from nerve stretching in cases of pressure by cicatrices etc." In cases in which there has been an actual rupture of the nerve, with the formation of an intervening band of fibrous tissue, the plan of cutting out the fibrous portion, and joining the true nerve tissue, has frequently been followed by complete recovery of M function. In this case, however, the retention of the sensory function showed that the nerve was not destroyed, and, besides, the fibrosis was diffuse and not localised. No doubt some surgeons have resected

*A.A. Bowlby Loc. cit. page 348

large portions of ~~xkm~~ nerve, filling up the gap with a scaffolding of nerve tissue or catgut, but the symptoms here were not sufficiently clamant to call for such a step.

Some Considerations on the Pathology of Multiple Peripheral Neuritis

The foundation of a true conception of the pathology of peripheral neuritis, was laid by Duménil of Rouen in 1864. Nearly forty years before that, however, Graves* had stated his belief, that the cause of certain forms of generalised paralysis, was to be found in disease, not of the spinal cord or higher nervous centres, but of the nervous cords themselves. This idea lay dormant till Duménil described the presence of a definite neuritis, as found at autopsy in a case of acute ascending paralysis. In a second paper, published two years afterwards, he pointed out that, although the weight of the disease falls on the nerves themselves, the spinal cord is not always free from changes. It is interesting to note the facts which this acute observer saw, with the methods at his disposal. He found†† in the small nerves of the hands and feet, only a small number

"of primitive bundles, and the nerves showed an increase of "connective tissue, and a large number of fat cells. In in-"dividual fibres there was a want of continuity of the my-

* R.J. Graves "Clinical Lectures on the Practice of Medicine" 1884 Vol I page 578

†† L. Duménil quoted by Rosse & Bury (Loc. cit p.4) who give a full bibliography of all the earlier work on the subject.

"elin sheath, which, when present, manifested a marked degree "of granular degeneration". The changes noted in the cord were:- "The cells of the anterior horn were pale, and with- "out distinct nucleus, whilst the processes were few in num- "ber, some of them being so decomposed as to be scarcely re- "cognisable".

In the following years, cases with the clinical features of peripheral neuritis were reported, but were considered to be due to disease of the spinal cord, as Duménil's observations had failed to make sufficient impression. Whatever work was done seems to have been accomplished by the French pathologists. No great advance was made till about 1880, when the theory of a multiple neuritis, to account for certain forms of generalised paralysis, assumed a definite shape, the work of Leyden being important. In 1881 Dr Grainger Stewart reported the first cases in this country, in which the diagnosis of peripheral neuritis had been made. Two of the cases recovered, but the third died, and the nerves were examined by Dr Hamilton, afterwards professor of pathology at Aberdeen.

Running parallel with this development of the path-

-ology of generalised peripheral neuritis, there were certain other observations contributing to the same end. In 1862 Charcot and Vulpian found in a case of diphtheria, a degeneration of the nerves of the palate, similar to that following nerve section. In 1871 Lancereaux described the same condition in the nerves in lead palsy, and his observations were confirmed by others. The late Dr Dreschfeld* of Manchester was the first in this country, to adduce anatomical evidence in favour of the neuritic origin & of alcoholic paralysis, and, at the same time, he brought under a common pathology, the conditions resulting from poisoning by lead, arsenic, diphtheria, and alcohol, and grouped them under the title "peripheral" or "multiple" neuritis. His paper on "Alcoholic Paralysis" was published in 1884, after which the facts gained general acceptance, and very numerous contributions were made to the subject.

The extent to which pathological investigation of this disease had been carried in 1890, may be judged from the views expressed in Ross and Bury's Treatise, which, from the clinical side still remains the most exhaustive work on the subject in English literature. The microscopic

*J Dreschfeld "On Alcoholic Neuritis" "Brain" 1884 p 200

examinations in their cases of alcoholic neuritis, were made by Dr R.T.Williamson.* Various nerves were examined, and the most marked changes were found in the finest twigs, the least in the larger trunks. Extensive fatty degeneration of the myelin was found, and the fat was collected at points, so as to cause swellings of the fibres, with intervening constrictions. At some parts the axis cylinders persisted, at others they had completely disappeared. Increase of the interstitial tissue was observed, in which were many round and oval nuclei. The empty sheaths of Schwann could still be seen as filaments, thin, transparent, and delicate. Examination of the spinal cord showed in some cases, certain changes in the ganglion cells of the anterior horn, which were "probably somewhat destitute of processes and altered "in other minor respects, but the changes were exceedingly "slight and doubtful". Examination of the muscles showed increase of muscle corpuscles, but no loss of striation.

Nevertheless, although the only constant pathological lesions, discovered up till that time, were in the peripheral nerve trunks, Dr Judson Bury,†† in his summing-up took a very broad view of the disease. He is careful to define

*Ross and Bury Loc. cit. page 139 et ff.
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his terms, and he accepts the position taken by Buzzard, that it must be clearly understood, "that the word neuritis "is not restricted to inflammation of a nerve, but that it "includes degeneration, atrophy, or any other kind of dis-"ease affecting a nerve". No doubt exception might be taken to this, on the ground that the termination "itis" ought to correspond to inflammation: but "neuritis" has held its position too long in our nosology to be lightly superseded, and there is the widest divergence of opinion as to what constitutes inflammation.

Bury discusses the method, by which the toxin in the blood acts on the peripheral nervous system, and he propounds the question, "What influence does the central ner-"vous system exercise, on the distribution and character of "the symptoms, presented by peripheral neuritis"? He conceives of three ways, in which the limitation of the changes to the peripheral nerves may be explained:- (1)"The poison "selects and attacks those parts solely and predominantly; "(2)it primarily attacks nerve cells, and as a consequence, "those portions of the nerve fibres viz. the peripheral, "which are furthest removed from their influence, undergo

"degeneration; (3) the poison acts with equal intensity on "nerve cells and nerve fibres; the former recover, but the "latter, having been robbed for a time of vitality, have lost "resisting power, and degeneration, already started, stead-"ily progresses".

Even now, with the great advances in nerve histology, a final answer has not been given to the question propounded above. Dr Bury's view at that time was, that allowing for the lowered vitality of central cells, he still inferred, "that cases exist, in which the peripheral portions "alone are attacked, the central portions of the nervous sys-"tem presenting no affinity for the particular poison"... "Nevertheless", he added, "in the majority of cases, evi-"dence is usually forthcoming, that the brain or cord or both "are attacked along with the nerves".

Now, in regard to this last sentence it should be said, that this view was supported by certain pathologists, and as vigorously opposed by others, who had failed to find any lesion in the spinal cord or brain. As observations have been accumulated under improved technique, the position of those who limit the changes to the periphery has gradually

weakened.

The wide conception of the disease (advocated by Dr Bury) was gaining ground in 1895, for we find Dr Seymour Sharkey* saying, in opening a discussion on the Pathology of Peripheral Neuritis, "It would be well to consider, whether "we have not been trying to draw too sharp a line, between "the peripheral and central nervous systems, whether we have "not been too anxious to limit the pathology of many of these "diseases to the nerves, while the various agents which pro-"duce them, cause alterations in the centres as well".

This change of view was greatly strengthened by the general acceptance of that new conception of the nervous system, which arose out of the histological discoveries of Ramon y Cajal of Barcelona. This observer, working with the Golgi method, was able to show that the nerve cell, with its various branches, is the unit of which the nervous system is composed, and that there is no structural continuity between such elements. The term "neuron" was introduced by Waldeyer to designate this unit, and has been generally accepted. The outcome of this new idea has been to give an explanation of many facts previously obscure, and to bring

*Seymour J Sharkey "On the Pathology of Peripheral Neuritis" The Lancet 10/8/95

a much greater definiteness, into the conception and investigation of the nervous system. The peripheral nerves are now always considered with their cell body, and it is found that there is a very close agreement between these as regards health.

Anatomical Section

Something may be said here, concerning the anatomy of a primary neuron, that is , one connected with a peripheral nerve: a good type is found in the ganglion cell of the anterior horn, with its motor fibre. The protoplasm of the nerve cell is described as consisting of cytolymph and cytoreticulum, and it contains a large nucleus and one or more nucleoli. In tissues hardened in alcohol and stained with methylene blue, certain deeply stained bodies are found, arranged in the meshes of the cytoreticulum, which, although they may be chemical artefacts, are found to give very significant information regarding the health of the cell. They were first described by Nissl in 1892, and the terms "Nissl bodies", "stainable", "chromatic", and "chromatophile" substance have been variously applied to them. In contrast with the stainable substance, the rest of the

cell is named "achromatic."

The main process of the cell, the axon or axis cylinder, passes to the periphery as a nerve fibre; the other processes, the dendrons, which are often very numerous, branch in all directions, and form connections (without continuity) with those of other cells. Nissl bodies are found in the dendrons, but not in the axon. A delicate fibrillation of the neurons is described by many observers.and seems to be generally accepted. but there is no uniformity of observation regarding this. Some* describe the fibrils as passing from one dendron to another at the outskirts of the cell, and from the dendrons to the axon, while others** depict them as taking origin in a perinuclear feltwork. There is general agreement in ascribing to the fibrils a function of conduction. The achromatic substance is now held to be the essential part of the cell. Various other refinements of structure are described, many of which await confirmation.

Soon after leaving the cell body, the axon receives a covering of myelin - a liquid fatty substance, lying in a complex network of neurokeratin. The myelin is known

* eg. Sir Wm Gowers Loc. Cit page 56

** W Ford Robertson "The Pathology of Mental Diseases" 1900 p. 198

also as the white substance of Schwann, or the medullary sheath. This is kept in place by a delicate membrane, the primitive sheath or neurilemma. The axon maintains its course (except that it gives off delicate collateral fibres) till near its termination, where it breaks up into numerous branches, each with its covering of myelin and neurilemma, which pass to the end organ in the structure supplied.

The myelin is interrupted at short intervals (the nodes of Ranvier) and in this way segments are formed. In each segment there is a nucleus, closely applied to the inner side of the neurilemma, having a small amount of attenuated protoplasm of its own, and known as the neurilemma nucleus. Besides the break in the myelin at the nodes of Ranvier, there are other, finer, notches in it - the slits of Lantermann.

In the case of peripheral sensory nerves, the cell is situated in the posterior ganglion and only one process is given off. This soon divides into an ascending process entering the cord, and another descending to the periphery, whose structure is the same as that described above.

The sympathetic fibres are partly non-medullated; they do not call for special mention here.

The supporting substance in a peripheral nerve, consists of connective tissue, which is divided thus:- the endoneurium, a delicate tissue between the individual fibres: the perineurium, a laminated fibrous tissue, surrounding one or more groups of fibres: and the epineurium, a general sheath, enveloping all the bundles of a nerve. The nerve is supplied with blood vessels and "nervi nervorum," while lymphatics, lined with endothelial cells, lead from the delicate endoneurium.

In a mixed nerve the fibres are not grouped according to function, nor have any laws been laid down, as to the actual position of the different sets of fibres.

Physiological Section

While there is a fair amount of agreement, as to the main points mentioned above, regarding the anatomy of the neuron, very diverse theories are maintained, with regard to the physiological function of the different parts. It is generally held, that the cell body with its nucleus controls the metabolism of the neuron, that is to say,

that neither axis cylinder nor dendrons can be healthy, unless they are in connection with this trophic centre. The grey matter of the cord is in intimate connection with the capillary plexuses, and the larger cells are surrounded by a pericellular lymphatic space. Does the cell then actually take up nutriment for the whole neuron? While it is impossible to answer this question with certainty, it would seem that the peripheral nerve to a large extent obtains its own nutriment. It probably does so in virtue of its neurilemma sheath. There is strong evidence, that a healthy condition of the neurilemma is essential to the life of the axis cylinder, and, conversely, a lesion of the axon leads to an abnormal state of the neurilemma. There are observers who, minimising the influence of the nerve cell and its nucleus, conceive of each segment of the peripheral nerve as a histological unit, whose nutrition is maintained by the neurilemma nucleus, which is further able, they say, to reproduce the axis cylinder, if it be destroyed. This will be referred to below under "Regeneration". At the other extreme we have those who "magnify the office" of the nerve cell and its nucleus, considering them to be the sole distributors of nutriment. Barker,* after considering various

*L.F. Barker "The Nervous System & its Constituent Neurons" 1900 Page 307

hypotheses, concludes thus: "Personally, I rather favour "the view, that instead of assuming an actual transportation "of a chemical substance, we can well conceive of a variety "of excitation, which, starting from the cell, perhaps even "from the nucleus, streams constantly through the axon, and "in some way, perhaps by a process comparable to electro- "lysis, maintains the chemical condition suitable for the "assimilation of the nutrient juices, a view entirely com- "patible with the fact, that the trophic action of the cell "body, appears to be least active in the parts of the axon "most distant from it".

Degeneration and Regeneration of Nerves

With regard to what takes place after section of a peripheral nerve, something must be said here, as on this hangs our conception of neuritis. Waller's Law, that a nerve fibre undergoes destructive changes, whenever it is separated from the cell from which it springs, was enunciated more than fifty years ago. The process was more fully worked out by Ranvier,* who describes the following series of events.

"Within the 24 hours, which follow the section of

* Ranvier quoted by Pitres & Vaillard Loc. cit. page 51

"a nerve, the nuclei of the interannular segments of the
" (of the distal end) hypertrophy. The protoplasm around
"each nucleus increases and is extended, as a continuous
"granular lamina, under the membrane of Schwann, and at cer-
"tain points encroaches on the myelin sheath, whose edges
"become sinuous and scalloped. Towards the 50th hour, the
"modifications betray themselves further. The slits of Lan-
"termann become deep notches filled with granular protoplasm;
"the notches, increasing, finish by interrupting the con-
"tinuity of the myelin sheath. The latter, at first divided
"into irregular fragments, breaks up into balls of unequal
"size. The exuberant protoplasm attacks the axis cylinder in
"its turn, and cuts it towards the end of the third day; the
"débris of this thread is found from place to place, in the
"middle of the fragments or balls of myelin. Towards the 4th
"day, the proliferation of segmental nuclei appears, each of
"them multiplies after the classical mode of division. On
"the following days, the nuclear proliferation continues, the
"protoplasm becomes more abundant, and the myelin divides
"into an infinity of balls and granulations. From the 20th
"to the 30th day the alteration is accomplished. The nuclei

"cease to multiply. The myelin, in great part destroyed or "altered, persists still at some points of the nerve tube, "where it accumulates forming moniliform swellings. In the "interval between these swellings the fibre is compressed, "and its lumen is occupied by oval nuclei."

The neurilemma cells seem to act as phagocytes in the removal of the debris. Ranvier and others believed that there is also an immigration of leucocytes for this purpose, but this is not certain. Fleming* says that he finds little evidence of their entrance.

It is now known, that more or less definite changes take place in the fibres of the central end of a cut nerve, and in their cells of origin. These are slow in onset, and the myelin suffers more than the axis cylinders. The motor fibres diminish in number; in some instances they vanish almost totally, and a large number of the motor cells of the ventral horns dwindle in size, and may after a time be actually lost. Changes are also produced in the sensory fibres and posterior ganglion cells - in the latter at an early stage (Fleming)††. The employment of Nissl's method has shown

*Robt A. Fleming "Observations on the Histology of Medullated Nerve Fibres" Jour^l of Anatomy & Physiology Vol XXXI p. 406

†† — do — "Ascending Degeneration in Mixed Nerves" Edinburgh Medical Journal Jany 1897

cellular changes soon after section, in the chromatic elements.

As a corollary to Waller's Law, regeneration occurs only by downward growth from the central end. It is believed that the axis cylinders have the power of growth, and send processes which enter the empty neurilemma sheaths of the peripheral end, after junction has been effected.

A unanimous consent has not been accorded to this dictum regarding regeneration. Its first opponents were Vulpian and Phillipeaux soon after Waller's time, but their views were accepted by a very small minority. In this country Bowlby, from his surgical work, came to the conclusion that the peripheral end regained by itself a more or less healthy condition: but it was the publication of Kennedy's* paper in 1897, which chiefly aroused interest in the matter. This was followed by the work of Ballance and Stewart.++

Kennedy's views were based on the contention, which his own results (with those of many other surgeons) seemed to show, that in cases of secondary suture of nerves sensory function was rapidly restored, and motor power returned more slowly, but quite definitely. His histological

*Robt Kennedy "On the Regeneration of Nerves" Philosophical Transactions of the Royal Society 1897

++Charles A Ballance & Purves Stewart "The Healing of Nerves" London 1901

investigations convinced him, that though the old axis cylinders are destroyed in the peripheral end, new nerve fibres originate there, in virtue of the cells of the neurilemma, without there being any connection with the central end. The maturation of the new fibre, however, is not completed while separation of the ends exists, and only takes place after suture.

The work of Ballance and Purves Stewart contains the record of a very detailed histological investigation, and they present many elaborate drawings in support of their views. The essential feature of their theory is, as in Kennedy's, that the neurilemma cells, becoming neuroblasts, have the power of forming new nerve tissue. Staining by the Golgi method, they describe the formation of threads of axis cylinders, at the side of the spindle-shaped neuroblasts, which threads increase and join longitudinally. The process, they say, produces only imperfect axons until a connection with the central end is effected, when completion results.

We have then, these two definite and opposed theories. If the peripheral theory of regeneration is correct, the neuron theory is no longer tenable. Ballance and Purves

Stewart perfectly realise this, and cite other available evidence in their endeavour to discredit this widely accepted view of the nervous system. Kennedy's and their supporters are mainly in the ranks of the surgeons, while their opponents are chiefly physiologists.

From the latter's point of view the whole subject has recently been re-investigated by Professor Halliburton,* who adduces very strong evidence in favour of the central theory. In conjunction with Mott and Edmunds he conducted many experiments, and in his paper he also discusses the leading results and theories of other workers. He puts great stress on the nutritional function of the neurilemma in the nerve. After degeneration he describes the proliferated neurilemma & cells as forming empty sheaths. He has been quite unable to verify the statement that they form any new nerve tissue, but believes that the new axis cylinders pass into these sheaths from the central end, when connection is re-established, and that they find in them both a scaffolding and a nutrient membrane. He adds: "The neurilemmal act-
"ivity appears to be essential, for without it, as in the cen-
"tral nervous system, regeneration does not take place".

*W.D. Halliburton "On New Facts in relation to the Processes of Nervous Degeneration & Regeneration" British Medical Journal 11/5/07

The clinical investigations of Head* also bear strongly in this direction. This observer, besides recording the cases of many patients, had two sensory nerves cut on his own arm, and carefully watched the return of sensation. Coarser (or protopathic) sensation only commenced after two months, and recovery was not completed before nine months in the most successful cases - a fact which accords with the idea of a slow downward growth centrifugally. He was quite unable to verify the return of sensation within a week, which is reported by Kennedy.

A study of these various views has led the writer to accept the central theory of regeneration, which accords with the Wallerian doctrine and the neuron concept.

Pathological Section

We pass now to the actual changes which take place in neuritis. As was explained above, the term is understood to include degeneration rf the nerves, as well as inflammation proper. Acute inflammation of the nerves is uncommon, their sheath providing a good protection against local microbic invasion. With the chronic interstitial neuritis, which is of varied origin, I do not propose to deal here, a brief

* Henry Head & James Sherren } "The Consequences of Injury to the Peripheral Nerves in Man" "Brain" 1905 Part Cx Chap 2

reference having been made to it, in discussing a special case. The following remarks are devoted to a consideration of parenchymatous peripheral neuritis, to which the term toxic may usually be applied. The poisons which affect the peripheral nerves (through the medium of the circulation) are very numerous, the chief being alcohol, arsenic, lead, carbon monoxide, mercury, and the toxins of diphtheria, enteric fever, influenza, diabetes, septicaemia, tuberculosis, and other diseases; almost every constitutional affection has been shown to give rise, at times, to peripheral neuritis, local or widespread.

The selective action of these toxic substances is one of the most interesting points in regard to them. Thus the toxin of diphtheria attacks chiefly the nerves of the palate, lead affects the nerve supply of the extensors of the wrist and hand, but usually leaves the supinator longus untouched, while in the case of alcohol the distribution of the lesions is widespread, but it shows a preference for the extensor muscles of the extremities. Beyond a hypothesis of chemical affinity, between the particular poison and the affected parts, no explanation has been given of this select-

ive action. The investigations of Dr Dixon Mann,* however, regarding cases of arsenical poisoning in beer drinkers are interesting. He showed that arsenic picks out the keratin tissues, for which it has a special attraction, and is recoverable from the hair, nails, skin, and specially from the nerves in virtue of their neurokeratin. Mann gave his opinion that the action of the arsenic was chiefly on the ~~xxxx~~ nerve cells, which had been weakened by alcoholic excess. He compared the action of arsenic on nerve cells to that of phosphorus, which has been shown by Mott++ to prevent the storage of oxygen in their protoplasm.

As alcoholic cases are the most common, they will be taken as giving the type of parenchymatous neuritis. Naked eye examination of the nerves is usually negative, and a microscopic examination of specially stained sections is necessary. The Weigert-Pal stain shows the healthy fibres in contrast with any degenerate ones: the Marchi stain, in virtue of its osmic acid, picks out the fatty matter (which has resulted from the splitting-up of the lecithin of the medullary sheath); while, for the other histological elements, such ordinary stains as haematoxylon and eosin suffice. There are

* J Dixon Mann Contribution to Discussion on "Peripheral Neuritis in Beer Drinkers" "The Lancet" 10/8/01

++ F.W. Mott Article on the "General Pathology of Nutrition" in Allbut & Rolleston's System of Medicine 1905 Vol I p575

many other stains employed by different histologists, to which it is unnecessary to refer in this paper.

A leading feature of peripheral neuritis is, that the trunk of a nerve may appear perfectly healthy, at a time when there is marked degeneration in the terminal fibres, the changes increasing as the finest twigs are reached. In many cases, the change in the nerve fibres is the same as that secondary to section of a nerve, and described above: that is, it closely resembles Wallerian degeneration. But this change does not occur simultaneously in all the fibres of a nerve, as healthy and degenerate ones are mingled in a seemingly indiscriminate manner. All stages of decay may be visible, from granulation of the medullary sheath and increase of internodal nuclei, to complete destruction of axis cylinders, accompanied by removal of the débris by the phagocytes. In some cases, where the nerve is not recovering, there is a proliferation of connective tissue - a "replacement-fibrosis".

In addition to these changes, a condition, described first by Gombault, has also been found, which he designated "periaxial segmentary neuritis." In this, the primary change is a disintegration of the myelin in scattered seg-

ments, accompanied by proliferation of their neurilemma nuclei. Diseased segments are found alternating with healthy ones. The axis cylinder in many cases persists without apparent change, but sometimes is found to show true Wallerian degeneration. The process takes place at different levels in the fibres, and here and there spindle-shaped swellings are produced by the accumulation of fatty globules.

A description has thus been given of some of the appearances found in the affected nerves, and, inasmuch as they so frequently and closely resemble the results after section or injury, we are led to enquire if there may not be some lesion to which they are secondary. Allowing that the cause is a toxin in the blood, how does this reach the peripheral nerve fibres? Our answer to this question depends on our view of the physiology of the nerves. The writer has stated his adherence to the view, that the nerve cell controls the activity of the neuron, while at the same time the nutritition of the fibres is largely obtained locally, by means of the neurilemma cells. In accordance with this idea, a toxin in the circulation may affect the peripheral nerve fibres in two ways: (1) locally through the neurilemma sheath (2) centrally by its action on the nerve cells.

(1) The local action of toxins on nerve fibres.

The manner in which blood-carried toxins act on the specialised tissues which they select, has been well studied in various tissues of the body. It has been carefully worked out in the case of the heart muscle by Dr John Cowan,* and it seems not unreasonable to suppose, that a parallel process takes place in nerves. Cowan points out, that the cardiac degenerations are in direct relationship to the blood supply; if the blood be toxic, the degenerations (granular, fatty, or fibroid) are situated around the arterioles, while the parts further off are unaffected; and, conversely, in cases of starvation of cells from anaemia, the lesions are at the points furthest from the small vessels, that is, where the blood reaches last. At the same time he shows that the accompanying vascular changes occur in the shape of intimal thickening, with the vicious circle which follows. As regards diseases of the brain, the intimate relationship between the degeneration of neurons and local vascular disorders is one of the master-ideas of Dr Ford Robertsen's ++ book on the subject.

In considering whether an analogous process occurs

* John M. Cowan "The Cardiac Muscle" Edinburgh Medical Journal Feby 1904 p. 127

++ W Ford Robertson Loc. cit.

in the peripheral nerves, the work of Dr R.A.Fleming* calls for special notice. This investigator, more than any other whom the writer knows, has studied the nutrient vessels and supporting structure of the nerves in toxic peripheral neuritis. The vascular changes which he describes, are in the arterioles and capillaries of the endoneurium and perineurium, and they increase as the periphery is reached. They are, distension and proliferation of the endothelial cells of the intima, and to a less extent similar increase of the nuclei in the media and adventitia. There is a considerable amount of exudation at certain points with an emigration of leucocytes, and diapedesis of red blood corpuscles, and where this process is of longer standing, there is proliferation of the connective tissue cells surrounding the vessels. These changes are associated with degeneration of nerve fibres, and he conceives that the point at which the process starts, is where the fibre is in closest nutritional connection with the toxic blood. He propounds the view, that the process of degeneration commences first in the fine fibres, which, he says, are of the vaso-motor order, and peculiarly vulnerable.

In theorising on his observations, he starts with

*R.A. Fleming "Notes of Two Cases of Peripheral Neuritis" "Brain" Spring Number 1897 page 176 ff.

the fixed idea, that the primary change must be in the nerve cell: this becomes deteriorated by the toxin with the result that its fibre is weakened, and when the latter commences to degenerate, the process is greatly expedited by the effusion resulting from the vascular change. The mode of action of this effusion is, he believes, that of pressure, harmful, but not sufficient, as a rule, to wholly cut off the distal part of the nerve from its central connection. This pressure would not occasion degenerative changes in a healthy nerve.

It is somewhat difficult to follow Fleming's theory with regard to the part played by the fine fibres, and it must be allowed that the number of cases reported by him is small. Ballance and Stewart disagree with him, as regards vulnerability of the fine fibres, and believe that degeneration occurs more readily in the larger ones. Nevertheless, the actual observations and drawings of Fleming are of great interest, in their suggestion of a process, analogous to that which is seen in other parenchymatous tissues.

With reference to the recovery of nerves in peripheral neuritis, which is a frequent occurrence, the question of regeneration arises. Fleming* investigated some cases

*R.A. Fleming "The Peripheral Theory of Regeneration with special reference to Peripheral Neuritis." Scottish Medical & Surgical Journal Sept 1902

of alcoholic neuritis, in the light of the work of Kennedy and his followers, and convinced himself that he saw evidence of neuroblastic regeneration; at the same time he allowed that this was very difficult to detect. Since then he has, I believe, seen reason to doubt the correctness of the peripheral theory. To those who uphold the central view of regeneration, the essential fact is that the nerve cell should retain its vitality. When this is so , recovery is possible, even after a peripheral degeneration as complete as that following section.

(2)The action of toxins on the cell bodies.

I have already indicated , that the question of changes in the cell bodies of the affected nerves has often been considered. In 1883 Erb* advanced the hypothesis "that "in cases of multiple neuritis due to toxic agents, some "slight changes in the cells in the spinal cord, not visible "to the microscope, are present primarily, and that the "changes in the nerves are secondary, the nutrient power of "the cell being incapable of supporting the entire axon, "which thus shows changes in its most distal parts". This idea of Erb's was a theoretical conception, without ocular

* Quoted by M. Allen Starr Loc. cit page 44

demonstration, but the employment of Nissl's method of staining has shown cellular changes in many cases of disease of the peripheral nerves. The question is as to whether they are primary or secondary.

It has already been said that section of a nerve leads to secondary changes in its cell body, chromatolytic and atrophic. Investigations in this line in peripheral neuritis, have shown that a similar, but more extensive, change occurs there. It must be granted that all observers do not agree on this, but the evidence in favour of central changes is accumulating, and may be expected to do so. Dr W.K.Hunter* for example, investigated five cases of definite toxic neuritis, and his results may be summarised here. In all cases he found parenchymatous neuritis of the peripheral nerves, and, accompanying this were extensive chromatolytic changes of the motor cells. The various stages of the chromatolysis noted by him were: fragmenting of the Nissl bodies, giving the plasma of the cell a finely powdered appearance; disappearance of the granules; loss of the nucleus, and the production of an empty sheath or "ghost cell". Along with these there was in many of the cells a quantity of yellow pigment,

*Walter K Hunter "The Changes in Motor Ganglion Cells in Peripheral Neuritis" "The Lancet" 5/8/00

Further changes have been noted by various observers, and are summarised thus by Bury:* "Chronic inflammation of the membranes, especially of the pia mater: an irregularly disseminated myelitis; and in some cases an overgrowth of connective tissue, throughout the cord, often especially marked in the posterior columns".

On the other hand, we find such an authority as Dr R.T.Williamson++ writing in 1901, "Microscopic changes in the central nervous system are rare, and when present are usually slight". He then refers to the work of Marinesco and others, and says that the degeneration of anterior horn cells, recorded by them, is probably secondary. Marinesco on his part, maintains that he can distinguish primary and secondary degenerations of the nerve cells, by noting the different modes of chromatolysis, and that he has found them both in neuritis. Other observers, while agreeing with his classification, have been unable to follow his differentiations practically, so that the important question, as to whether the cells are involved primarily or secondarily, is still unanswered from a histological point of view. Ford

* J.S Bury Art on "Multiple Symmetrical Peripheral Neuritis" Allbutt's System of Medicine 1st Edn Vol VI p. 685

++ R.T. Williamson Art on "Multiple Peripheral Neuritis" Encyclopaedia Medica Vol III page 300

the significance of which is uncertain.

Recovery is possible after a certain degree of chromatolysis, and, indeed, the trend of later investigations has been in the direction of minimising its actual pathological significance; the fact of recovery after extreme degrees of it.* is in line with the hopeful prognosis, which may often be given in toxic peripheral neuritis (Judson Bury)††. Lesions of the achromatic part of the cell are now held to be more serious, and it is doubtful if they can be repaired (Lugaro)‡. Information on this point is, however, still indefinite.

The cells of the anterior horn which Hunter found diseased, were those of the postero-lateral group, the antero-lateral and anterior being almost invariably normal. This was so in the lumbar and cervical regions, while the ganglion cells in the dorsal region were mostly normal, a condition which accords with the distribution in the nerves. Changes in the spinal ganglia have also been noted.

*George Lamb, Walter A Hunter } "On the Action of Venoms of Different Species of Poisonous Snakes on the Nervous System" "The Lancet" Aug 20th 1904 &c.

†† Judson S Bury "Prognosis in Relation to Disease of the Nervous System" The Bradshaw Lecture 1901

‡ Lugaro quoted by Ford Robertson Loc. cit 256

Robertson* states his belief, that there are in peripheral neuritis examples of both primary and secondary affections of the ganglion cells of the anterior cornua.

When we consider the matter clinically, however, and remember that we may have the motor, sensory, and vaso-motor fibres of a particular nerve affected by a circulating toxin, it seems highly probable, that the initial lesion has not been in the cell bodies of these fibres (so widely separated in the cord and ganglia), but in the peripheral nerves themselves.

No description of peripheral neuritis would be complete, which did not take note of the fact, that lesions of a degenerative nature are found commonly in many of the other tissues of the body. Reference has already been made to this, in dealing with a case of chronic alcoholism (case I) A characteristic dementia is among the commonest signs of implication of the higher nervous elements. Much work has been done on the cerebral pathology of this condition, from which it appears that there is great degeneration of the large cortical cells. Ford Robertson lays great stress on the fact, that successive periods of over-indulgence lead to

* W. Ford Robertson Loc. cit. page 263

to actual destruction of these cells, which cannot be replaced. He is also careful to point out that in such chronic intoxications, there is the added factor of poisons absorbed from the alimentary canal, due to catarrhal and other lesions there. A third point likewise requires to be emphasised, viz., that the susceptibility of nerve cells to poisons varies greatly in different individuals. Other and similar lesions are found in the heart, kidneys, liver etc., and thus though peripheral neuritis gives the name to the affection, the picture is frequently that of a general degeneration of specialised tissues.