Sciatic Nerve Series.—Ten of these were suture of external popliteal and the remainder were cases in which the whole sciatic had been severed. Of the former four gained a perfect result, and of the latter only two gained a perfect result.

Throughout the whole six series of 98 cases the only ones which had any proper pre-operative or post-operative treatment by means of splints were a few of the musculo-spiral cases. In the great majority of cases it was not until patients came to our department that any postural treatment was adopted, and in many cases months elapsed between the wound and operation, and between the latter and admission to our department. The results of these six series of cases, aggregating 98 in all, do not agree with some of the glowing reports found in the literature. Professor Tinell in his book estimated that 85 per cent. of his cases had recovered or would recover. He of course acknowledges that all were under the best circumstances for recovery, whatever he means by that. Even taking the most liberal estimate of my cases we find that 51 per cent. represents the standard of recovery, and I feel sure that this figure greatly exceeds the real truth, especially if one regards recovery from the point of functional usefulness apart from mere academic recovery of muscle movement. I have erred on the liberal side in estimating recovery, and do not think that many of the cases (if any) in column "Good" will progress any further.

The results on the whole, then, are in some measure disappointing, considering the tremendous amount of regenerative power that the axis cylinders possess, probably more than any other tissues in the body; and yet the results are encouraging when one considers the many unfavourable factors militating against success in almost every case. Some of these factors have been mentioned above and need not be here reconsidered. The question of the lapse of time between receipt of injury and suture of nerve is very hard to evaluate. Some cases that were operated upon a few hours after being wounded did badly, whereas others which were not operated upon for months did well. Of the operative technique I cannot speak, as cases were done by many different surgeons, but I feel sure that it was good, as the majority were operated upon by surgeons whose ability is well known.

A big factor associated, as I have before stated, with practically every case has been the neglect of pre-operative and post-operative postural treatment by means of splints, etc. This neglect, I feel sure, has been responsible for most of the failures, especially with regard to the delicate intrinsic muscles of the hand. It is not to be expected that these muscles will recover so easily as the other larger muscles. Being situated more distally they are at a marked disadvantage from the point of view, first, of time required for processes to grow into them; secondly, the small size of the nerve trunk as it spreads peripherally renders the march of the new processes more difficult, and these small muscles are pulled out of position very easily by the contracture of antagonistic groups, and this with such delicate organs must greatly injure them.

With regard to post-operative treatment, I have not been much impressed with electrical methods, and in future I shall not employ them at all, or only to a very limited extent. It is impossible to know exactly what one is doing in many cases, and probably more harm than good results from violent shocks to sick muscle engines. Scheft showed in 1851, and Professor Langley confirmed his results (*Journal of Physiology*, July, 1916), that a denervated muscle is in a state of fibrillation. It seems to me that, such being the case, it is the height of absurdity to send comparatively violent electrical stimuli into a muscle in a condition like this. There is one thing above all that it requires, and that is rest—complete rest—and this can only be done by the application of appropriate splints, so as to control all joints over which the muscle acts, thus placing it in a condition of maximum relaxation. This is difficult to obtain fully in many cases, but it is the end to be aimed at, and ingenuity and experience can enable one to design splints, etc., to do this.

Hartman and Blaky, in an extensive research on the subject reported in the *Journal of the American Medical Association*, March 22nd, 1920, performed a series of experiments on rabbits, denervating the muscles of the hind legs, and then applying the recognized forms of treatment. They came to the conclusion that neither massage nor

galvanism had the slightest effect in preventing atrophy of muscles—the only positive conclusion that they came to was that the more perfect the coaptation of the divided nerves the more perfect was the result. They did not try the effect of splinting or postural treatment at all; in fact, they used passive movements daily, which to my mind rather vitiates their results, as, unless these movements are done very carefully, stretching of the sick muscle results and does harm, as W. C. Mackenzie has shown in his work on the paralyses following acute anterior poliomyelitis.

I am convinced that we have as a profession not yet grasped the overwhelming importance of rest—perfect rest—and gradual re-education to muscles that have been injured by denervation from whatever cause. In Australia we should have wakened up to this problem much sooner, as it has been preached to us for the past ten years. It must be emphasized that a denervated muscle is a sick muscle (sick unto death almost), and that we must apply to it the cardinal principle that runs all through our treatment of almost every pathological condition. This applies much more forcibly to such small muscles as the intrinsic muscles of the hand and the muscles of the face, more especially as these are always placed at a great disadvantage by the stretching of the antagonistic groups.

As regards recovery of sensation, my experience has been that this is practically never perfect, but in a great many cases some recovery of sensation returns, and this of itself is of great advantage to the individual, protecting him from burns and other injuries, and also indirectly leading to an increase of nutritional activity.

FIVE CASES OF RAT-BITE FEVER:

TWO CASES TREATED SUCCESSFULLY BY
NOVARSENOBILLON.

BY

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JUDGING from my experience, I am inclined to think that this remarkable disease is not so rare as is generally supposed. It has been well recognized in Japan since 1899, and some 40 cases have been recorded there. But it was not until 1910 that Sir T. J. Horder¹ published an account of three cases of rat-bite fever, stating that they were "instances of a disease hitherto undescribed, at least in this country." Since then single cases have been recorded by Dr. G. S. Middleton,² by Dr. R. W. Cruickshank,³ by Dr. J. O'Carroll,⁴ by Professor R. Tanner Hewlett and Dr. G. H. Rodman,⁵ by Dr. F. Nicholson,⁶ and by Dr. J. H. Nixon.⁷ Dr. A. G. Atkinson⁸ had one case under his own observation, and collected the particulars of 5 other cases, which he published for the first time, together with an excellent account of what is known about this disease.

Since 1897 I have seen five patients suffering from rat-bite fever, all of whom came from different parts of Norfolk. In addition, I have been told of a few other cases, some of which at least were probably instances of the same disease.

Three of my patients were in the Norfolk and Norwich Hospital, one was seen with Dr. G. Calthrop in the Wells Cottage Hospital, and the fifth was seen in consultation with Dr. W. Royden, of Flegg Burgh. The cardinal features of the disease were present in all my cases, and are so characteristic that if the existence of such a malady is known its diagnosis is easy. There are also a number of less constant symptoms; these are set out by Dr. Atkinson, and I propose only to refer to some of them and to give briefly the notes of three of my cases. The mortality of rat-bite fever in Japan is stated to be 10 per cent.

The fifteen published cases in Great Britain and my own five cases all eventually recovered. It has been noted as one of the features of the malady, as seen in this country, that there is a tendency to its spontaneous subsidence, but its course may be a very long one and the patients are usually gravely ill. In different cases the duration has varied between a few months and as many years. Until recently it was agreed that no treatment was of any avail. The periodic attacks of fever have led to the trial of large doses of quinine, but this and a number of other drugs—

CASE I.—Novarsenobillon 0.45 gram was injected on November 25th.

including atoxyl—have been found useless. Now, however, we have information on the organism which causes the disease, and the last two patients had the benefit of a rational method of treatment which promises to be a cure.

Many different micro-organisms had been found in the past by some observers, and their presence refuted by others. Horder's cases were thoroughly investigated, but with negative results. From two of my patients the blood, and fluid from puncture of inflamed skin in one, have been examined by Dr. G. P. C. Claridge, but he found no organism, and there was no growth on culture media. Other observers have also agreed that there was nothing to be found in the blood or elsewhere.

I am indebted to Dr. Atkinson for having my attention called to a publication by Mr. A. G. R. Foulerton,⁹ describing *Spirochaeta morsus muris*. This organism has been found by Japanese investigators "in the blood of one, out of forty-three apparently healthy house rats examined. Inoculation of a white mouse with the blood of this rat was followed by an infection identical with that produced by inoculation with material from human cases." The negative results obtained by ordinary examination and by culture of the patients' blood are explained, for the demonstration of the spirochaete by direct examination is stated to be difficult. But if white mice are inoculated with the blood, or with exudation from the skin, or with liquid from the affected glands of a human patient suffering from rat-bite fever, the spirochaete can be demonstrated in the mouse's blood. Mr. Foulerton kindly undertook to make some inoculation experiments with the blood of Case III. Six guinea-pigs were inoculated with blood drawn during two bouts of fever, four of the animals have remained quite well, and in none of them have any spirochaetes been detected. Mr. Foulerton writes: "But the clinical evidence leaves no doubt whatever as to the nature of the case, and it appears that others have found the experimental confirmation, by inoculation with patient's blood, somewhat uncertain of result."

Before this spirochaete had been identified as the cause of rat-bite fever its treatment with salvarsan had been advocated by S. Hata.¹⁰ He used salvarsan in eight cases. Five were immediately cured, a sixth case was benefited, and the remaining two cases improved temporarily, but relapsed later. In regard, however, to these last two cases, the author explains that they did not receive a large enough dose. In Case I of mine an intravenous injection of novarsenobillon 0.45 gram was given by Dr. Claridge. As will be seen from the chart an immediate effect was produced, and for the next five weeks the patient had no recurrence of the febrile attacks. Moreover, all the local inflammatory manifestations at once began to clear up, and his general condition to improve markedly. So he returned home to complete his convalescence. Five weeks later it appeared, however, that he was not quite cured. There occurred a rise of temperature to 101.4° and a transient erythema on the limbs. Dr. G. C. Gaynor, under whose care he was at home, gave him a second intravenous injection of novarsenobillon 0.6 gram, and the temperature remained normal for the next seven weeks, while he continued to regain weight and strength and was able to resume work. Two more similar doses were given at intervals of two and three weeks, as the temperature again rose on single occasions to 100°, with reappearance of the rash. Three months after his first dose, which was followed by subsequent injections at irregular intervals, the patient appears finally cured and has regained twenty-two pounds of weight.

In Case III the first injection of novarsenobillon was followed by a similar abrupt cessation of fever. Three

more doses were given at regular intervals of a week, but from the time of the first injection he made an uninterrupted recovery as regards every feature of his illness.

If a conclusion may be come to from the experience of these two cases, I would say that a single dose of novarsenobillon puts a stop to the recurring attacks of high fever, and reduces all the inflammatory affections of lymphatics and skin. But, as in the case of *Spirochaeta pallida*, the injection must be repeated at regular intervals of a week to complete the cure.

I will give briefly the notes of three of the patients:

CASE I.

I. H. B., aged 54, was admitted into the Norfolk and Norwich Hospital, under my colleague Dr. A. J. Cleveland, who was kind enough to transfer him to me for the purpose of this communication. He had never been ill previously. On October 3rd, 1920, while rat-catching, he was bitten on the left index finger by a ferret which had killed and partly eaten several rats. There were four small punctures on the finger which quickly healed, and never showed at all after the first few days. On October 15th he began to feel ill, and the left axillary glands enlarged. A few days later he was seen by Dr. Gaynor, who noted lymphangitis and lymphadenitis of the left arm, with areas of inflamed skin in other parts, and attacks of fever every few days. On October 25th, on admission to hospital, the patient was obviously very ill; he had a muddy complexion, and was heavy and prostrate. On examination the striking feature was lymphangitis. This could not be traced directly from the bitten finger, but was most marked over both shoulders. Coursing from the tops of each shoulder, over their anterior aspects to the axillae, were three or four parallel red lines. These could be seen and felt to be of about the thickness of the stem of a clinical thermometer. The glands in the right axilla were less enlarged than those in the left axilla, but the lymphangitis was equally marked on the two sides, and less obtrusive affection of the vessels was seen in both arms. Another phenomenon was the occurrence of circular patches of erythema on the forehead, the face, the chest, the upper abdomen, and the forearms. The larger of these were about an inch in diameter; they were red in colour, with a yellowish inner ring. Some were so prominent and swollen as to suggest the presence of pus. With each febrile attack these inflammatory affections of the lymphatics and of the skin would become aggravated and fresh lesions would appear. My patient had a little diarrhoea for a few days, and during each attack of fever he complained also of much soreness and dryness of the throat, where some congestion was apparent.

For the first three weeks of the illness he had epididymitis of moderate degree on the left side, which gave him some pain during its existence, but which subsided readily while the other symptoms were at their height. This is a complication which I have not found recorded by others, but it is interesting to read in Foulerton's paper that on *post-mortem* examination of a patient in Japan there was found a single spirochaete in the testicle, while numbers were found in the kidneys and suprarenal glands.

The striking characteristic of rat-bite fever is indicated in the accompanying chart. With almost the punctuality of malaria, every few days the temperature rose sharply, and there was an exacerbation of all symptoms and signs. The fever persisted for from a few hours to a couple of days, and then the temperature became lower and remained so for a certain number of days. The afebrile intervals lasted about three days, and there was a tendency for these to lengthen as the illness went on. In other cases these intervals have extended to a week, but periodicity has been equally marked. This patient's treatment by injections of novarsenobillon has been already referred to.

My first case of rat-bite fever occurred in 1897. Its true nature was not recognized at the time, it was diagnosed as ague and was referred to by Professor G. H. F. Nuttall¹¹ as the last case of indigenous ague in England. I am now, however, satisfied, from looking up the excellent

CASE II.

notes of the house-physician, Dr. E. S. Verdon, that in reality it was a case of rat-bite fever in a man who had once been subject to malaria.

CASE II.

W. A., aged 49, was admitted under my care into the Norfolk and Norwich Hospital on December 11th, 1897. He had always lived in Acle, which stands in the centre of a district known for its rivers, broads and marshes, and where *Anopheles maculipennis* is still constantly found. At the age of 10 he had ague, but no mention is made in the notes of recurrence. Nine weeks before coming under my care he had been bitten by a rat in the palm below the right wrist. A local abscess formed, and there was lymphangitis up the arm. An incision had been made, but the skin remained red and indurated. Lymphangitis of the right arm and forearm was the conspicuous condition, but he also had patches of erythema on the other arm. He had paroxysms of fever, shivering and sweating at intervals of from two to four days, along with which it is recorded that the inflammation in the arms increased. Dyspeptic symptoms with frequent vomiting occurred during the whole illness. It was particularly recorded in the notes that quinine in doses up to twenty grains failed to avert the attacks of fever, the last of which occurred fifteen weeks after the bite. Many examinations of his blood were made by Dr. S. H. Long, who at length found a few malarial plasmodia. This finding was confirmed by Professor Nuttall, who saw the slide, which is still in Dr. Long's possession.

In this case there is the history of a rat bite followed after an incubation period by lymphangitis and widespread

surface of the body, of the face, and of the limbs was covered with an extensive papular rash. This was darkish red in colour and with each attack of fever the papules enlarged and fresh ones appeared. The spleen was just palpable and remained slightly enlarged during the illness. On the palmar surface of the right thumb was a sore as large as a florin; this was covered by a yellow slough and surrounded by red skin. There was marked lymphangitis from the thumb up the forearm and the axillary glands on the right side were enlarged and painful.

A blood count showed 11,100 white cells and no eosinophilia. The attacks of fever are represented in the accompanying chart. As these came on the patient complained of severe headache, he felt cold, then followed profuse sweating and occasional vomiting. On one night he was delirious with the fever.

On the evening of the day following his first injection of novarsenobillon the temperature fell, and there was no further recurrence of the attacks of fever, which had previously appeared with more or less regularity every forty-eight hours. Moreover, from this time the rash and the lymphangitis began to fade rapidly and the spleen was no longer palpable. He quickly regained the appearance and feeling of health, and his complete recovery was uninterrupted. I believe that this result was due to his receiving three further doses of novarsenobillon at intervals of a week after his first injection, and without waiting to see if any relapse took place.

In my other two cases the illness was of considerable

CASE III.

patches of erythema. The paroxysms of fever were not quite punctual in their recurrence and were not controlled by quinine. But the notes quote the patient's statement that they resembled the attacks of ague from which he had definitely suffered thirty-nine years previously and plasmodia were identified by Nuttall and Long. The incidence of rat-bite fever in an old malarial subject, who still harboured the organism of the latter malady, is most remarkable, because the resemblance of the two diseases has been always referred to by writers on rat-bite fever. The temperature chart from the hospital case-book is appended.

CASE III.

S. H., aged 38, was admitted into the Norfolk and Norwich Hospital on March 14th, 1921, under the care of Mr. C. Noon, on account of a septic sore on the thumb with attacks of high fever. I am indebted to Mr. Noon and to his house-surgeon, Mr. P. Murphy, for the following notes and for opportunity to watch the case. The patient was bitten by a rat on February 15th and the small wound on the right thumb healed rapidly under local treatment. About twelve days later there were pain and tenderness at the site of the bite, which increased during the next few days and then extended up the forearm to the axilla. On March 3rd the thumb was incised by his doctor, but no pus was found. Headache, sleeplessness, and slight sore throat, with increasing feverishness, were complained of, and he was sent to the hospital. There he presented the aspect of acute illness, with flushed face and injected conjunctivae. The

severity and was marked by the same type of intermittent fever, extending in one patient over three months and in the other over six months. Two and three weeks elapsed between the bite of the rat and the onset of symptoms. In both patients the wound had healed in the interval, and there was no suppuration. One of the patients had much lymphangitis and lymphadenitis, but the other had only an eruption of boils on the skin. In one of Atkinson's cases the illness was followed by a series of boils.

Without recounting my cases at greater length, I would say that the points of rat-bite fever are as follows: The illness is caused by the bite of a rat, or, as in one of my cases and in one of Atkinson's, by the bite of a ferret, or, as in another of his, by the bite of a kitten—all these animals having just bitten the body of a rat.

There is an incubation period, whose duration in my five cases was from 12 to 21 days, which corresponds with that observed by Atkinson. But the incubation period may extend to two months, as in the cases of Hata and of Hewlett and Rodman. During this period the wound may or may not have healed, and the onset of illness may be associated with fresh inflammation of the wound or of the scar.

Fever of a characteristic type has been the cardinal feature of all cases in this country, though it should be

mentioned that an afebrile form of the disease is described by Japanese writers. There are periodic sharp rises of temperature, which may be accompanied by a rigor. The intervals of normal temperature last three or more days, and the attacks come with some punctuality. With each attack the local inflammations are increased, and there are usually such general symptoms as great malaise, prostration, pains in the limbs, vomiting, diarrhoea, and soreness of the throat.

Swelling of the tongue and definite swellings in different muscles characterized two of Atkinson's cases. The virus of the disease appears particularly to affect the lymphatic system. The constant presence of intense lymphangitis is noted by Japanese writers, and this was the striking feature in four of my cases. It was present in half the cases collected by Atkinson. Enlargement of lymphatic glands has been more common in English cases, though in one of Horder's cases this was absent. Suppuration is often thought to be threatening, but this does not occur except rarely in the wound.

A form of erythema was present in two-thirds of Atkinson's cases and in four of my five cases. Of Horder's three cases it was absent in one, where the only local affection was firm oedema of the bitten arm. In one of my patients the inflamed patches were suggestive of erythema nodosum, but they were more raised, and the only colour effect was the presence of a concentric yellowish ring within the border of the circular red patch.

An Italian case of rat-bite fever, after two years' illness developed retro-ocular cellulitis and exophthalmos. Albuminuria with dropsy has been recorded in several cases; one of my patients had oedema of the feet towards the end of his illness, but there was no albumin in the urine. The occurrence of epididymitis in one of my patients has been mentioned, while in another there was slight but palpable enlargement of the spleen.

Leucocytosis is present as a rule, and increases with each attack of fever. But O'Carroll's case had marked anaemia and a white cell count of 7,200. In this case and in an Italian case eosinophilia was present, though in others its absence is noteworthy. Dr. Claridge's examination of the blood of my patient, I. H. B., gave 23,300 leucocytes with the following differential count: Polymorphs 91.7 per cent., transitionals 1.6 per cent., lymphocytes 5.8 per cent., eosinophils 0.9 per cent.

Rat-bite fever is a serious illness, as testified to by a medical man who himself suffered from it in 1896. He was seen by several eminent doctors, and thought then to have some form of blood-poisoning. Dr. G. Master's case is now included in Dr. Atkinson's account of rat-bite fever, and he writes to me:

"I was away from work for seven months and did not feel fit for eighteen months after the start of my illness. The wasting was extreme; I could make my two hands meet round my waist, and at one time I could not turn myself in bed. Treatment did not seem to help in any way."

It now appears that rat-bite fever can be added to the list of diseases for which the cause and the efficient remedy have been found.

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THE TREATMENT OF CUTANEOUS ANTHRAX.

BY

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AND

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AN editorial article in the *BRITISH MEDICAL JOURNAL* of February 5th, 1921, on the question of anthrax in shaving brushes was concerned mainly with the source of the infected supplies and the methods of dealing with them, but there was a short discussion on means of treatment, in which it was stated that excision of the pustule is no longer recommended. In response to an inquiry the Editor kindly referred us to Circular 172 issued by the

Ministry of Health, January 28th, 1921, from which the following paragraph is quoted:

"Treatment of Persons Infected."

"In general, the best treatment for a case of anthrax is physiological rest of the part affected, combined with intravenous injection of anti-anthrax serum—60 to 80 c.cm. on the first day and 60 c.cm. on the day following, if there has been no reaction (shown by a rise of temperature) and the general condition has not improved. Excision is unnecessary. Subcutaneous injection into the abdominal wall of 30 c.cm. has apparently been successful in many cases, repeated, if necessary, on successive days. Difficulty is always met with in estimating the efficacy of different methods of treatment of a malady such as anthrax, which is capable of undergoing spontaneous cure. But the following figures, supplied by the medical inspector of factories, with regard to the results of various forms of treatment in 800 cases of cutaneous anthrax (excluding the erysipelatous form) in Great Britain, support the above conclusion:

Treatment.	Cases.	Deaths.	Mortality per cent.
Serum only	200	8	4.0
Excision only	397	44	11.1
Excision and serum	174	25	14.4
No special treatment	29	14	48.3
Total	800	91	11.4"

At Guy's Hospital, where a few cases of anthrax are admitted every year, and where the possibility of infection is always present in the minds of those in charge of the surgery owing to the special character of the industries of the borough, the practice for some time past has been to combine excision with serum treatment. It is therefore interesting to compare our figures with those quoted above. We have taken the years 1909 to 1919 because it was only in the year 1910 that serum began to be used regularly. Records for 1918 are unfortunately incomplete. Since 1910 the majority of cases have been treated both by excision and serum, but it is only since 1916 that the serum has been given in doses as large as those recommended in the above circular. In going through the reports all those cases have been omitted where adequate details confirming the diagnosis were absent, or those in which anthrax bacilli were not discovered, though on clinical signs they have been classified as anthrax.

Treatment.	Cases.	Deaths.	Mortality per cent.
Serum only	4	1	25.0
Excision only	6	1	16.6
Excision and serum	37	3	8.1
Treatment not specified	1	1	—
Total	48	6	12.5

The number of cases in this series is obviously far too small to allow conclusions to be drawn from them with any convincing degree of certainty. The gradation of falsehoods into three classes, of which the superlative is "statistics," is a familiar one in political discussion; but it applies with even more force to statistics in medicine or surgery, for the sources of error are innumerable. Successes are nearly all published, very often before they have stood the test of time; failures are as commonly buried in oblivion. Very few series are large enough to exclude the element of chance. But, apart from the factor of the individual and the allowances that must be made for enthusiasm, many other sources of error come in. One is accuracy of diagnosis. Were all cases admitted to Guy's Hospital as anthrax on clinical evidence and not confirmed by discovery of the bacillus to be included, the mortality of the series would be very materially reduced.

This factor of accuracy in diagnosis is especially important in all statistics bearing on the mortality of the surgical treatment of exophthalmic goitre. Another factor is the severity of the type of case which is admitted to any institution. If the death rate from fractures of the base of the skull at different hospitals be examined, it will be found to range from about