lambs separated from another field by a fence through which only the lambs can pass. Just as the attraction between oppositely charged ions prevents either from leaving the membrane to any great distance, so the attraction of food and parental care prevents both the ewes and the lambs from wandering very far from each other, although on one side of the fence the lambs will be in the majority, on the other side the ewes.

At one time I was inclined to think that these areas of localized sweating might be connected in some way with Head's areas of referred pain, but further investigation showed that it was impossible to refer them to any definite lesions in the nerve centres.

We have, in any case, another kind of "nerve-leak" of a more distinctly physiological origin. It is, when metallic electrodes are used, associated with the first kind, and the result on the galvanometer is the algebraical sum of the two together. Without any further hypothesis, they are capable of accounting for all the results. But Mr. Baines holds that these results are to be explained by static charges and "inductive capacity." I have made numerous attempts to detect the production of currents by giving charges to insulated bodies connected by electrodes to the galvanometer and have failed altogether. Indeed, since the points led off must be equipotential whatever the magnitude of the charge given, it is difficult to see how currents could be produced. The charge, as Faraday showed, is situated on the surface and cannot affect processes going on in the interior of the body tissues. Static charge may, I hold, be rejected. What about "inductive capacity"? I found some difficulty in discovering how Mr. Baines imagines this to play a part. But, ultimately, it turned out to be this: The galvanometer deflection obtained from a patient is found to be very sensitive to the passing of electric trains, but, instead of looking for the cause in action upon the magnetic system, Mr. Baines attributes the deflection to currents induced in the human body which are being led off. This seems almost inconceivable in a skilled electrician, but no other evidence is given.

In Mr. Baines's theories there is a flow of what he calls "neuro-electricity" along nerves. This is stated to be a kind of ordinary electricity, so nearly the same that it passes as such around the coils of the galvanometer. If this be so, nerves, when cut and the ends placed in contact and insulated from the exterior, should conduct impulses, not of course giving rise to co-ordinate movements, but to movements of some kind. In point of fact, they do not, as is common knowledge. The source of this "neuro-electricity" is supposed to be the brain and by atomic disintegration. No proof of any kind is given, and, whatever may be the nature of the nerve impulse, it is certain that there is no continuous stream of energy, and all that we know points to its being connected with the concentration of certain ions at membranes.

I pass on to the method of treatment founded on the theory of neuro-electricity. This is the application of "dielectric oil," or similar preparation, which are supposed to act as insulators and thus stop the leaks. Not only are the nerve-leaks of shell shock cured, but also all inflammatory states, such as pneumonia and so forth. All living cells are stated to lose their "vitality" if deprived of their supply of nerve energy. That this is incorrect is shown in a striking way by the experiments of Clara Jacobson, who showed that wounds in a denervated limb heal quite as rapidly as those in a normal limb.

What is this "dielectric oil"? It is merely a good specimen of ordinary liquid paraffin; in fact, its insulating properties are rather inferior to those of a preparation which I obtained from Messrs. Hopkin and Williams. I have made a detailed investigation of the chemical and physical properties of various paraffins, but was unable to find any possessed by the "dielectric oil" beyond those of other commercial samples. More especially it is easy to show that it does not penetrate the skin. If it did so, the electrical resistance would rise. The electrical resistance does not change. Further, the dielectric oil loses the greater part of its insulating power by contact with salt solutions, as it must be in the skin and tissues.

There is no doubt that liquid paraffin is a pleasant dressing for raw wounds; it is protective, and to some extent excludes infection by micro-organisms. But it has no effect on the results of general infection.

In the attempt to explain the curative results obtained, apart from those obviously due to suggestion, it is necessary to bear in mind the great difficulty of avoiding the fallacy of concluding that a phenomenon which follows another in time is the direct result of the former one. Thus, when the temperature in pneumonia falls after the application of "dielectric" to the front of the chest, how do we know that the temperature would not have fallen without the dielectric? In any case, I cannot accept it as a proof of penetration *through* the chest that the bed-clothes beneath the patient were found soaked with paraffin three hours after its application to the front of the chest. It is rather remarkable that, in Mr. Baines's list of the important properties of his "dielectric," that of low surface tension is omitted.

In conclusion, I might say that it would be unjust to blame those medical men who have adopted the theories of Mr. Baines. They deal with a very complex branch of physiological science, although it is not so complex as Mr. Baines would have it.

The net results of my investigations may be summed up thus:

1. Currents led off from various parts of the body by metallic electrodes are due to inequalities in the electrodes, together with differences in the activity of the skin glands.

2. Neither static charges nor induction plays any part.

3. "Nerve-leaks" are merely places where the skin is moist, and they give no indication of lesions in the nerve centres.

4. The view that "neuro-electricity" is generated in the brain and escapes from nerves owing to breakdown of insulation is devoid of evidence and contrary to the knowledge we possess of physiological processes.

5. My examination of Baines's "dielectric oil" leads me to conclude that it is ordinary liquid paraffin; that it does not pass through the skin and cannot reach any nerve or other internal tissue.

6. Treatment of open wounds by liquid paraffin has some justification in excluding air and perhaps bacterial infection. But it is not new. The results obtained have no relation to insulating properties, and the "dielectric" has no superiority in this respect over commercial samples.

OPERATIVE TREATMENT OF INJURY OF THE PERIPHERAL NERVES.

BY

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TYPICAL points of doubt and difficulty that present themselves to the surgeon in the treatment of cases of nerve injury may be grouped under the following heads: I, How soon after the reception of the nerve injury should an operation be performed? II, What are the indications for operation as derived from the study of the signs and symptoms? III, Points of difficulty and doubt as regards correct or best procedure and technique arising during the actual operation.

I.—THE INDICATIONS IN TIME FOR OPERATION.

All wounds caused by present-day projectiles, even those produced by rifle and machine-gun bullets that enter and emerge through tiny skin punctures, must be regarded as infected. The complication of a nerve injury by sepsis, or the involvement of a nerve trunk in a septic inflammatory process, appears to be fatal to that regeneration of nerve fibres which leads to and is the indispensable basis of the re-establishment of conductivity in the segment of the injured nerve and distal to it that clinically we designate "recovery." Neither the reason for this nor its pathological basis is far to seek; nowadays, when so many damaged nerves are being operated on, the former is again and again made clear by, and the latter exemplified in, the excessive production of scar tissue by the infective inflammatory process. This excess of scar tissue, with the different position or positions in which it finds itself produced, seems to act in different ways towards its one unfortunate end. These are as follows:

1. Scar tissue formed between the ends of a completely or incompletely anatomically divided nerve which have

retracted a variable distance, in this position acting effectively in preventing regeneration.

2. Scar tissue between the fibres or bundles of fibres of the nerve trunk, producing the typical spindle-shaped swellings of a localized interstitial neuritis. Here it may be the result of the organization of blood effused at the time of injury. This usually occurs in one or both of the ends of an anatomically divided nerve as well as in a damaged segment of a physiologically complete or incomplete lesion; or it may be the result of a slower and more gradual irritation and inflammation of the affected segment of the nerve.

3. When a segment has been more severely damaged by a projectile than a mere bruising, and yet not completely cut through, we may find the fibres and nervous structure of part or whole of its cross section replaced by scar tissue—complete or incomplete fibrosis of the nerve. At operation this part appears more opaque and of a smaller circumference, feels harder to the finger, and cuts harder to the knife than does normal nerve.

4. Scar tissue, whether organized blood clot, callus, or the usual fibrous product of infective inflammation, is very frequently found in considerable masses surrounding a segment of nerve. This affected portion itself may be the seat of no gross or macroscopic lesion except that in many cases the fibres will be degenerated. Indeed, it is often surprising how leanly in the end it dissects out of such a mass. This scar tissue, either directly or possibly by interfering with the nutrition of the fibres, blocks conduction, often causes degeneration, and interferes with regeneration.

5. In some cases extraneural scar tissue is present not in the form of masses or bands from which the nerve dissects free, but in the form of perineural adhesions, strands of scar tissue which blend indissolubly with the perineurium. This seems to be the result of a septic cellulitis in the intermuscular plane in which the nerve lies. Such adhesions are often very numerous, extend over a considerable length of the nerve, and very effectively prevent, or at least render difficult, the process of nerve-stretching. In two cases, the most extreme instances of this form of perineuritis that the writer has noticed, the nerve itself having been cut through by a piece of shell, was in a state of subsiding acute inflammation—smaller in diameter than usual, red and congested, and with little trace of nerve bundles for a considerable distance up and down from the original lesion. Probably in these cases an acute septic neuritis, spreading up and down from the point of division, had accompanied the extraneural cellulitis. In another case the condition of perineural adhesions was complicated by complete fibrosis of the nerve, the posterior interosseous, well down to its point of distribution of motor fibres and up to and including the lower part of the musculo-spiral. Probably, also, this was the late result of such an acute spreading neuritis as we have just described. Probably, also, this combination of destructive fibrosis over a considerable length with extensive adhesions is the final pathological outcome in cases where sepsis follows an operation of resection and suture.

In most cases there is present a combination of several of these pathological conditions described. Any operation, then, on an injured nerve which is carried out through already infected tissues will only spread such mischievous processes up and down—up to what is normal and healthy nerve, and down to what is healthy though degenerated. Hence it becomes axiomatic that no operation should be performed on the nerve for the relief of paralysis, etc., in the presence in the tissues of micro-organisms. Even where the divided nerve presents itself in an open wound or is found during the course of an operation with other objective, steps taken to do more than suture temporarily the ends to prevent further retraction or remove any foreign body or piece of bone, etc., actually pressing on the nerve are contraindicated and unjustifiable.

How long, then, after the sound healing of the wound and disappearance of all scabs is it necessary that one should wait? It is well recognized that the mere healing of a wound gives no very dependable assurance, at any rate for some time, that micro-organisms are not latent in the tissues; especially is this true as regards the healing, which is often temporary, of sinuses due to the presence of foreign bodies or to caries and necrosis of bone. On the other hand, it is generally admitted that secondary suture of nerves should be carried out as soon as possible,

and that the interval that elapses before it is performed has definite importance as regards the degree of success that may be expected as the result of the operation.

The question is one of considerable practical difficulty; it would seem that one must compromise between the two opposing desirables; but one may fairly safely conclude that there should be observed some definite relation between the "period of probation" of the healed wound considered desirable and decided on in each case, and (1) the depth and extent of the original wound, (2) the nature of the projectile that caused it, (3) the amount and character of the suppuration that ensued, (4) the length of the period of healing, (5) the presence in the tissues of further foreign bodies during this period, (6) the presence or absence originally of bony injury, necrosis, or caries.

There are very many cases of nerve injury where healing is almost indefinitely delayed and its period prolonged owing to original bony injury and infection—extensive or deep necrosis of bone, large cavities in bone, tunnels through bone with walls of necrosed or carious bone lined with septic granulations. In most of these direct operative interference for the cure of the nerve injury—unless this can be performed aseptically at a very safe distance—has to remain in abeyance for long periods, but treatment should be adopted as early as possible and made as radical as possible and as bold as is necessary for an early and rapid elimination of that factor in the injury which is responsible for the persistence of the suppurating track.

II.—THE INDICATIONS FOR OPERATION FROM CLINICAL SIGNS AND SYMPTOMS.

COMPLETE DIVISION.

Clinically, complete division may be either anatomical or physiological. This, however, is a difference that is not in the majority of cases diagnosable before operation. In some few cases—

(a) Where a previously recognized incomplete lesion has become clinically complete in the course of time;

(b) Where the clinical picture of "completeness" is associated with a palpable spindle, for example, in the case of the ulnar nerve behind the internal humeral condyle and where one can feel subcutaneously continuity between the spindle and the nerve trunk above and below;

(c) Where from the history of previous shooting pains or paraesthesiae which now have ceased—signs of incomplete division—one can deduce that the lesion has not been complete from the beginning;

(d) Where the track of the projectile is near, but obviously does not cross the path of the nerve—

the diagnosis of a physiologically complete division is possible. Although in the case of injury to the larger nerve trunks that fall into the groups (a) and (c) the condition may have been one of an imperfect or partial anatomical division, with a further later development of complete physiological division of the remaining anatomically intact part of the nerve trunk. In most cases, however, the diagnosis of complete physiological division cannot be carried so far.

How, then, should one treat a case presenting the picture of complete division, whether anatomical or physiological being unknown? If the lesion be an anatomical one, obviously the chance of spontaneous recovery is, to say the least, of the slenderest, if at all existent.

From a consideration of these points we would suggest, as a general guide, the following rules for the treatment of complete lesions.

When it is Not Known whether the Lesion be Anatomical or Physiological.

If it be unknown whether the lesion be anatomical or physiological, if there has been no sign of its becoming incomplete up to the end of the period of healing of the wound and of a further reasonable period of probation of the healed wound, operation should not be delayed, for one cannot be certain that the lesion is not anatomic, and if it be physiological, the lesion must be one in which spontaneous regression to recovery is unlikely.

When it is Known that the Lesion is Physiological.

If it be known that the lesion is physiological—that is, in all cases falling into groups (a), (b), (c), (d)—again operation should not be delayed beyond the periods of healing and probation, if during those periods the signs have not

regressed to clinical incompleteness; for in these cases what pathological conditions are conceivable that will, in their evil effects on regeneration and conductivity, be anything but stationary or progressive?

INCOMPLETE DIVISION.

Operative interference may be necessary and indicated in such cases for one or more of the following causes:

1. Where an incomplete lesion remains stationary after the wound has healed soundly and the disability remaining is serious or severe. Here, again, it would seem to be advisable to operate as early as possible for fear the lesion, incomplete though it be, is one in which there can be no chance of spontaneous regression and recovery.

2. Where an incomplete lesion is increasing in the severity of its clinical signs and the disability is serious from the beginning or becoming so.

3. Where after a nerve has recovered up to a certain point some serious disability remains.

The disability in these cases may be—

(a) *Motor*.—Paralysis of important muscles.

(b) *Sensory*.—Extensive protopathic loss in the foot or hand; extensive epicritic loss in the hand of a skilled manual worker.

In all these cases operation is all the more indicated, inasmuch as it is impossible to foretell the pathological condition present; it may be combined anatomic and physiological division, or severe fibrosis of a portion of the cross section of a nerve.

4. Because of persistent pain—for example, in causalgia—to give the patient relief; or for persistent hyperaesthesia or hyperalgesia which is severe and troublesome.

III.—DIFFICULTIES IN OPERATIVE TECHNIQUE AND PROCEDURE.

The chief objects to be aimed at in order to ensure an operation resulting in as complete a regeneration as possible—complete functional recovery depends as much on post-operative treatment as on operative—may be summed up as follows:

1. (a) Where the division is physiological, by the removal of such agents—for example, scar tissue—as are preventing physiological connexion or regeneration of fibres;

(b) Where the division is anatomical, by the procuring of sound physiological connexion between the two ends, by means of which normal fibres of the proximal end may grow into and along the paths of the degenerated fibres of the distal;

(c) Where the length of hopelessly damaged or destroyed nerve trunk is great, possibly by the procuring of physiological connexion between the degenerated paths of the distal end and the normal fibres of some neighbouring or conveniently situated nerve—

the object may be attained of laying the basis for regeneration and recovery of conductivity in the nerve trunk distal to the lesion.

2. The protection of the suture line from fibrous ingrowth and of the exposed length of the nerve from being surrounded by a further permanent mass of contracting or adherent scar tissue. This includes, of course, the observance of the most rigorous asepsis during the operation, and requires healing of the operation wound by first intention; and haemostasis as absolute as possible before closing the wound, as a collection of blood clot round or near the nerve not only constitutes an invitation to sepsis but is destined to become organized into fibrous tissue.

3. No further damage should be inflicted on the nerve by rough handling.

These conditions of success apply to all cases; the surgical methods of fulfilling them necessarily vary with the pathological and anatomical conditions of different cases, and in fulfilling them questions of doubt and difficulty arise in the case of all three.

1. THE PRODUCTION OF A BASIS OF PHYSIOLOGICAL CONNEXION FOR REGENERATION AND THE RE-ESTABLISHMENT OF CONDUCTIVITY.

A.—Where the Division is Clinically Complete.

1. Where the division is anatomical.

The two ends will be found usually considerably apart and surrounded by more or less scar tissue. The upper

end is always bulbous to a greater or less extent; the lower often but not always so.

To cut down on the obvious point of injury of a nerve and expect so to find it is always, and especially in cases of anatomic division, to prolong the operation. It is best always to find normal, or at any rate recognizable, nerve trunk above and trace it toward its entrance into scar tissue; then similarly recognizable nerve below, and trace it upwards; and finally to dissect out the ends or intervening more damaged portion and ascertain the exact nature of the injury and the exact condition of the ends or damaged segment.

It is necessary, or at least very desirable, to excise bulbous ends, unless the spindles are slight, arguing a relatively small amount of interstitial fibrous tissue. These bulbous ends are usually in a condition of severe interstitial neuritis, and their fibres, even of the proximal end, "compressed from within," degenerated, if not many actually destroyed beyond hope of regeneration. It should be made a rule, then, as regards the proximal end, to pare it with a sharp scalpel until the fibres appear in white and definite bundles with no abnormal amount of cellular tissues between; in some cases, however, where the nerve immediately above the spindle or directly damaged and fibrosed segment has been caused to degenerate without the occurrence of interstitial fibrosis by such a removable pathological agent as bands or masses of scar tissue, it will be necessary to carry the section of the nerve no higher than such a point as shows degenerated bundles without interstitial scar tissue. When there is present a spindle on the distal end, it too, if at all marked, should be excised; in all cases this end should be cut until the bundles show definitely, consisting of degenerated fibres—which bundles are always more swollen, more transparent than are normal undegenerated ones, and of a curious bluish-grey "glassy" appearance. Of course the resection should be as conservative as possible and as is consistent with the getting ground for a good physiological connexion between the fibres of the two ends; at the same time, if not performed boldly enough and scar tissue or part of a partially or completely fibrous spindle left at either end, the chance of the occurrence of regeneration will be slight, if not altogether destroyed.

It is best to stretch a nerve to the maximum amount probably needed or desirable before the removal of the spindles; not only does the spindle give one a good hold of the nerve for this process, but any bruising or damage sustained by it during the stretching is immaterial because of its subsequent resection.

2. Where the division is physiological and the pathological condition one of interstitial fibrosis, the nerve being swollen or spindle-shaped in the affected area.

Here, again, probably the best chance will be given if the nerve is first stretched and the spindle excised until the upper cut end shows normal and the lower a degenerated but otherwise normal cross-section. It may be argued that regeneration and recovery might occur without this, but here the argument in favour of resection is similar to that raised in considering the question of operation in cases of palpable spindle with signs of complete lesion.

3. Where the division is physiological, the pathological condition being one of complete fibrosis of a whole segment of the nerve trunk.

In this case of course there can be no question as to the necessity, after nerve-stretching, of resection of the whole injured segment and of as much above and below the obvious gross limits of the fibrosis as is sufficient to show the appearances of the cross-section described as essential.

4. Where the division is physiological and due to strangulation by or involvement in scar tissue, callus, etc.

Freeing the nerve from all strangulating and tight bands or masses will be sufficient, provided that these be the only cause present of degeneration or failure of conductivity. This should be done most carefully all round the nerve and along as great a length as is affected even in the slightest degree. Some surgeons advise the injection of novocain and adrenalin into the nerve trunk in order, by causing the nerve to swell, to make more evident bands which might otherwise escape notice.

When the nerve is quite freed, careful examination both by sight and feeling should be made for the detection of any area or segment of fibrosis in the nerve itself. If when the nerve be freed a spindle be found, at once difficulties arise. Was the failure of conduction due to the extraneural or to the intraneural fibrous tissue, or to both? If to both, will freeing alone be sufficient, or should one resect the swollen segment as well? Should one be satisfied with freeing for the present and reserve the more radical resection for a later operation, if no recovery succeed the freeing? These and questions like these mentally assail the surgeon, and they have to be decided quickly. If the spindle be large and hard it will no doubt be best to excise it at once; if not marked in degree and with the appearance and feel more of normal nerve trunk the surgeon will probably be well advised to defer resection to such later period as may show that regeneration or re-establishment of conduction is not occurring; but there will remain many intermediate cases where the indications are obscure.

Cases which, when the nerve be freed, show other accompanying lesions of the nerve—for example, partial or complete fibrosis—must be treated as described in the sections dealing with such lesions.

5. When the division is physiological and the lesion adherent perineuritis.

In the cases where this lesion has been found in conjunction with a clinically complete division, there has also been anatomical division or complete fibrosis of a segment of the nerve, as well as a considerable length of nerve above and below in an inflammation which has been acute, subsiding, or has gone on to the stage of fibrous tissue formation. In such cases probably all hope of spontaneous regeneration in the portion the seat of this inflammation or fibrosis must be abandoned; on account of the length of nerve, then, that would require resection such cases will be suitable for nerve transplantation or anastomosis. Where, however, such a process of fibrosis or destructive neuritis and perineuritis has descended the nerve so as to involve its important motor branches, direct operative devices all fail, and resort must be had to such indirect ones as are detailed concerning hopeless cases.

6. Where there is combined anatomical and physiological division, the physiological part of the lesion consisting of a spindle.

Resection of the whole thickness of the nerve will most probably be indicated. This condition is most likely to occur in the case of the great sciatic nerve.

7. Where there is combined anatomical and physiological division, the latter part consisting of fibrosis of the nerve.

Resection of the whole is absolutely indicated.

8. Where there is combined anatomical and physiological division, the latter part of the lesion being constriction or strangulation.

Freeing the one part with resection of the ends of the other is indicated. This lesion occurs most commonly in the case of the great sciatic nerve; fortunately the two portions of this nerve are often separate—if not they are always easily separable—up into the pelvis, so that the part anatomically divided can be stretched, resected, and sutured independently of the part with physiological division.

B.—Where the Division is Clinically Incomplete and Operative Interference is Desirable.

1. Where the division is physiological and the lesion a spindle.

Resection and suture will be indicated in most cases.

2. Where the division is physiological and the lesion strangulation by scar tissue, etc.

Freeing alone is indicated.

3. Where part only of the cross-section or thickness of the nerve trunk for a greater or less extent is replaced by fibrous tissue.

These cases are of great difficulty, and if they occur unexpectedly—as they are very liable to do—may puzzle

the surgeon very much. There would appear to be three different courses: (1) Leave the nerve alone; (2) resect the whole affected segment and resuture; (3) resect merely that portion that is fibrous, and after stretching split the nerve longitudinally, both up and down, and suture the upper cut portion to the lower.

As a general rule, it would seem right to adopt the first course where the loss—motor, sensory, trophic, etc.—is neither very extensive nor very important compared to the further loss that would result from complete resection; the second course, where the further loss risked and added would be slight in degree and relatively unimportant in nature and position compared to that already existing; the third course could then be adopted in cases clinically intermediate as regards these points between these extremes. In many cases, however, it is and will be very difficult to know which of these three procedures to adopt.

4. Where the lesion is merely perineural adhesions.

These should be freed as far as possible and the nerve well stretched.

5. Where there is combined anatomical completeness with physiological incompleteness.

Such conditions must be dealt with on the lines laid down in the preceding sections.

Of course in many cases two or more of the various pathological conditions described above coexist as component parts of the same lesion.

Again, the nerve may be damaged and the seat of one or more of the described pathological states at two or even more distinct points in its course. It is very essential that such should not be overlooked. This is liable to occur in cases where several wounds lie about or cross the path of the nerve, or, in the case of the musculo-spiral and other nerves coming into intimate relations with bones, where the nerve is not only affected directly by the projectile but also damaged or involved indirectly at some other point by a concomitant fracture of the contiguous bone.

NERVE TRANSPLANTATION AND NERVE ANASTOMOSIS.

One of the greatest problems as it is one of the greatest practical difficulties in present-day operative work on damaged nerves arises when, after stretching to the maximum amount possible or desirable and resection of the requisite amount of the nerve trunk or ends, it is not found possible to get the cut ends to meet, much less to procure accurate and close apposition of the cut surfaces.

Where the distance that remains to be bridged over is short, such possibly successful devices should first be tried as:

1. Adjustment and fixation of the segments of the limb or of the part the seat of operation—for example, by such flexion, such extension, etc., of neighbouring or concerned joints as will relax as far as possible the soft tissues in which the nerve is lying and also the tension of the nerve itself.

Some writers, however, have condemned the practice of this procedure on the ground that the strain put upon the suture line by subsequent working out of the fixed position of the limb is likely to cause the production of excessive fibrous tissue at that point.

2. Sometimes a shorter artificial path can be made through or between or over muscles. This has often the further advantage that the new path thus formed gives a bed for the sutured nerve more free from scar tissue and hence more favourable to regeneration.

3. When these do not suffice to bring the ends together, and but a very short distance still separates them, the strands of fine catgut of the suture may be trusted to act as conductors for the new fibres, especially if a tube of some animal membrane be carefully wrapped around both the nerve ends and the strands uniting them.

If, however, the gap be at all considerable then one has to resort to either of the following methods: (1) Nerve transplantation, (2) nerve anastomosis. The relative merits and demerits of these two procedures have as yet not been determined with any degree of certainty. Often, of course, anatomical and physical conditions decide for the surgeon which of the two to make use of in any particular case. In other cases this will be determined on grounds of theoretical consideration and probability.

Nerve Transplantation.

Conditions in which this method would seem to be indicated may be summed up in general terms as follows:

1. Where the distance to be bridged is relatively short.
2. Where no suitable or neighbouring nerve is available.
3. Where the affected nerve is of considerably less importance than the nerve to which it would have to be anastomosed.
4. Where, as in the case of the musculo-spiral, a suitable nerve for an autogenous graft (for example, the radial) is conveniently obtained.
5. Where a suitable homogenous graft is available.
6. Where the bed in which the graft will lie is composed of tissues favourable to the survival of the graft, which will not then run the risk of being strangled by fibrous tissue around it.

The nerves most favourable for use as autogenous grafts are the radial and the external cutaneous of the thigh.

Nerve Anastomosis.

On general grounds this procedure would seem to be indicated:

1. Where the distance to be bridged exceeds three inches.
2. Where a neighbouring nerve of considerably less importance and suitable size is available.
3. Where, if a graft were used, it would have to lie in a mass of already present scar tissue.

The varieties of anastomosis methods that are recommended are as follows:

1. *Partial Peripheral Anastomosis.*—The healthy though degenerated distal end of the affected nerve is inserted into a longitudinal slit in the sound nerve, if the nerves be small ones; if the nerves be large, the distal end of the affected nerve is sutured to a flap raised from the sound nerve at a point as far as possible proximal to the point of origin of any important branch.

2. *Implantation of both central and peripheral ends* of the affected nerve into longitudinal slits of the sound nerve may be advisable where the latter is chiefly or wholly sensory.

3. *Complete peripheral anastomosis* between the central end of the sound nerve, which is cut for the purpose, and the distal end of the affected nerve is justifiable only in very exceptional cases. Such a case was one in which the median nerve was destroyed from just above the wrist right up to the elbow. Inasmuch as the ulnar nerve in the hand—at any rate from the motor point of view—is a very much more important nerve than the median, it was not thought advisable to perform an anastomosis with it; but the radial was cut low down in the forearm and sutured to the distal end of the median. Of course, in this case all hope of recovery of power in those muscles of the hand supplied by the median was abandoned.

In the rare event of an ununited fracture of the bone of the limb segment being present with an extensive destruction of a nerve, shortening of the limb by resection of the bone would seem to be quite a justifiable procedure.

2. THE PREVENTION OF FIBROUS INGROWTH.

The necessity for the use of some wrapping material is still *sub judice*; on theoretical grounds at any rate it seems desirable. That Cargile membrane does not by the end of three weeks contract adhesions or absorb is proved by a recent case. At the first operation the writer removed an aneurysm of the third part of the axillary artery, an extensive lesion of the musculo-spiral nerve being found. It was found impossible to unite the ends, and strands of catgut were inserted, and they, with the divided ends, surrounded by membrane. Three weeks later the nerve was again operated upon, grafts of the radial and external cutaneous nerves being inserted; the Cargile membrane was found as it had been inserted.

The substances most frequently used for wrapping are Cargile membrane, hardened arterial tubes, segments of the internal saphenous or other large vein, and pieces of fascia lata and adipose tissue.

Some French surgeons, however, have recently been painting the nerves with sterilized olive oil in order to prevent fibrous ingrowth and the formation of dangerous adhesions.

OPERATIVE TREATMENT IN HOPELESS CASES.

Amputation.

The presence and recognition of injury to one or more nerves in a badly smashed limb may be the deciding factor in a decision to amputate.

Apart from such cases, however, one may be forced to amputate on direct account of the nerve injury:

1. Where after operation on the great sciatic nerve the sensory recovery does not get beyond the stage of recovery of protopathic sensibility with intense hyperalgesia.
2. Where recovery after operation on the nerves of the lower extremity does not include return of protopathic sensibility in the sole of the foot, and trophic sores and perforating ulcers cause trouble.

In hopeless cases or where motor recovery has not occurred, such operations as *muscle transplantation*, *arthrodesis*, and *insertion of artificial silk ligaments*, which have a recognized place in the treatment of infantile paralysis, may be performed with great advantage to the patient.

A CASE OF ENTEROSPASM IN WHICH THE PORTION OF INTESTINE INVOLVED WAS OF UNUSUAL EXTENT.

BY

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H. P. HAWKINS, in his comprehensive article on enterospasm,¹ says:

Without any change in the intestinal wall, one or more sections of the intestine may exhibit a purposeless tetanic contraction. It is thereby converted into a hard, nearly solid, cord, pale and bloodless.

The second case of Hawkins's series presented symptoms almost identical with those of the case here recorded.

A woman, aged 49 years, wife of a shipwright pensioner and mother of two grown-up children, for thirty years suffered from "indigestion," with vomiting on an average once a week; nine years ago the discomfort increased to actual pain, which occurred soon after ingestion of food, milk causing less pain than solid food. The vomiting gradually became more frequent. During the last five years she had had many family worries.

Condition when First Seen.

She was thin, with only a quarter of an inch of abdominal subcutaneous fat, and stated that four years ago she was quite plump. Vomiting was occurring once daily, usually after breakfast. The vomit had never contained blood. Constipation, with flatulence had existed for many years.

The only abnormality observed in the abdomen was a tender, ill-defined fullness situated between the umbilicus and the left costal margin. This tender area was constant. Nothing was observed on rectal and vaginal examination except a mobile retroverted uterus with an elongated cervix. A pessary had been worn for twenty years. Treatment by diet and drugs had given very little relief; the patient, neurasthenic, but not in the least hysterical, and of remarkable intelligence, willingly accepted an exploratory coeliotomy, fully appreciating the uncertainty of the benefits which operation might afford.

Operation.

Coeliotomy demonstrated that the stomach was enormously distended by gas, measuring in its greatest circumference 14 in., and that the duodenum was uniformly distended by gas (diameter 1½ in.). The small intestine was traced downwards for its whole length. The upper 3 ft. of jejunum were distended by gas to the size of the duodenum. Three feet from the duodenum the jejunum became abruptly narrowed, being in a state of intense contraction. The next 3 ft. of jejunum were uniformly contracted into a rugose, anaemic cord half an inch in diameter. Below the spastic area the rest of the small intestine was normal, as was the large bowel.

The other viscera showed no abnormality except undue mobility. Absence of fat was marked, the gastro-colic omentum being diaphanous. The head of the pancreas was so loosely attached that it, together with nearly the whole length of the duodenum, was easily lifted above the level of the abdominal skin. The abdomen was closed.

After-Course.

At the time of writing, a month after operation, the patient is taking ordinary food and does not vomit; the bowels act daily under paraffin and drachm doses of liquorice powder. Such post-operative improvement, with attention to the bowels and rest in bed, appears to be of common occurrence, but, unfortunately, is apt to be only temporary.

I have seen at operation a number of cases in which the small intestine was either found in, or quickly passed into, a