One of these should be attached to the distal cut end of the facial, and the other to the whole of its own distal end. This would abolish associated movements of the shoulder, or, at any rate, reduce it to a very small amount, for a few fibres at the angle of splitting would possibly be injured, resulting in their growing down the nerves to both sets of muscle. No very considerable atrophy of the muscles would take place after this, as the fibres of the central end would multiply at the point of suture.

It is suggested that nerve splitting should be made use of in the treatment of suitable cases of anterior poliomyelitis for the same reason.

In Part I of this paper it was suggested that nerve implantation would be of service where a considerable length of nerve was destroyed as the result of traumatism or other cause. It would be advisable, if possible, to make some use of the central end of the injured nerve. The following experiments were made to elucidate this point, and they show several interesting results.

Dog VII had the left leg operated on on September 3rd, 1904 (Fig. 2). About 1 in. of the external popliteal was removed. The internal popliteal was cut nearly half-way through, and into the gaps the central and peripheral ends of external popliteal were fixed by single sutures of chromicized catgut. Some superficial suppuration took place but did not extend deeply, and an ulcer formed over the os calcis, which subsequently healed. On December 22nd, 1904, the dog walked well, and rarely went over on the dorsum, except when standing on the hind legs, when the left foot doubled over; jumping was well performed. The leg muscles were smaller than those on the opposite side.

February 21st, 1905 (171 days). Dog was anaesthetized and the nerves stimulated. Internal popliteal and external popliteal were cut completely across at A and B, stimulation at A with the faradic current caused contraction of both flexor and extensor muscles of the toes, but the former were the more powerful. Stimulation of external popliteal at B caused the same thing, but not so vigorously, and the flexor muscles still predominated. After cutting the internal popliteal at C, stimulation here resulted in forcible contraction of the extensor muscles; in fact this was more powerful than on stimulation of the external popliteal at B.

In Dog VIII the same operation was performed and it was tested electrically after 128 days. Stimulation of the external popliteal at D resulted in contraction of the flexor muscles of the toes. After cutting the internal popliteal nearly half-way through at E (Fig. 2), this axon reflex was lost. This shows that it was probably only those fibres which were thus cut across at the operation which had divided and sent branches to antagonistic muscles.

It is evident that the trunk of the internal popliteal between the two points where external popliteal was implanted in it, contained at least four varieties of fibres which are shown in Fig. 3, and the condition is a very complex one.

Fig. 3.

Fig. 4.

A very important point is that it is presumably a matter of indifference what length of external popliteal is excised. After loss of a short part of a nerve trunk in a limb the two ends can be brought together by stretching the nerves and relaxing the limb. An interval of not more than 2 in. at the most can be bridged over by some material which offers an absorbable scaffolding down which nerve fibres can find their way. This is supposed to act as a guide to fibres coming from the central end, but I am not aware that this has actually

been proved. It seems immaterial what absorbable substance is used for this purpose. A piece of nerve excised from some animal apparently does no better than several strands of catgut. But none of these methods can offer the inducement that a degenerated nerve *in situ* does, for this exerts a definite chemiotactic attraction for nerve fibres to grow down it. When this interval of about 2 in. is exceeded the resources of surgery are at present very inadequate. Probably even at this limit the functional result would be unsatisfactory. The very extensive operation of shortening the limb by resecting the bone to allow of the separated ends of the nerve being approximated is advocated, but this results in mutilation and is a serious operation. Nerve implantation in these cases is almost ignored. Cheyne and Burghard² mention it only to condemn it.

The cause of failure seems to be due to the fact that only the sheath of the sound nerve is opened, and few, if any, of its fibres are divided. When the injured nerve is implanted in such a way it has no chance of getting any fibres to grow down its trunk. It is essential that considerable gaps dividing many of the fibres should be made in the second nerve, and into these gaps the central and peripheral ends of the injured one should be fixed. It is a dubious point as to whether one ought to use the central end of the injured nerve as in the above experiment. The hind legs of the dog do not allow one to judge accurately of the finer movements. As far as can be decided from these cases, it would be better not to use the central end in this way. Dog VII showed that the contraction resulting from stimulation of the external popliteal central to the graft was less vigorous than that resulting from the axon reflex, or in other words, the fibres actually proceeding from the central to the peripheral part of the implanted nerve produce less result than those which are coming from the sound nerve by axon splitting into the implanted nerve.

The alternative method allows of splitting of the healthy nerve and does away with the axon reflex. It can be easily seen that certain strands in a nerve occupy a particular position in the nerve trunk. For example, the external popliteal fasciculi occupy the outer part of the sciatic trunk, and can easily be dissected for a considerable distance up the thigh. In fact, they seem to be anatomically separate up to the pelvis, and it is not uncommon to find the sciatic nerve coming out of the sciatic foramen in two trunks, the external and internal popliteal separated by some of the fibres of the pyramidalis muscle. The same separation can be made for a shorter distance with the muscular twigs coming off from the nerve trunk. To apply this to the condition in question the piece of internal popliteal sutured to the distal end of the external popliteal can be separated up along the dotted line. (See Fig. 4.) If a short cut be made in this for the central end of the external popliteal to be inserted, some of the external popliteal's fibres would now reach their own distal trunk. At the same time few or none would run into the rest of the internal popliteal going to the flexor muscles, and no associated movements would result. A part of the internal popliteal which is split off plays somewhat the rôle of a graft (part shaded to the right of diagram), while the rest of the split consists of internal popliteal fibres going now by means of the external popliteal to the extensors of the toes and peronei. The actual condition of the nerves can be seen by a glance at the diagram. This form of nerve implantation would be chiefly applicable to the arm and forearm for anatomical reasons.

I have to thank Professor Osborne for many suggestions and for his valuable help in performing the electrical stimulation.

REFERENCES.

¹ Ballance and Purves Stewart, *BRITISH MEDICAL JOURNAL*, May 2nd, 1903. ² Cheyne and Burghard, *Manual of Surgical Treatment*.

A PROBABLE EXPLANATION OF SOME DROWNING ACCIDENTS.

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THE following experience occurred to me on July 8th, and may throw some light upon the too frequent occurrence of drowning accidents in swimmers.

I had been cycling on the morning round, covering perhaps about five miles altogether on indifferent roads. It was a very hot day, and I was perspiring freely, though the pace was easy. While returning about 1 p.m. I met a friend and

proposed a swim in the lodge* on the grounds connected with his house. To this he readily agreed, adding that perhaps it would put an edge on our appetites for lunch on such a hot day. Situated practically on the side of a hill this lodge is about 150 yards long by 10 or 12 yards broad. Its depth varies from a few inches on its upper side to 6 or 7 ft. near the embankment. It is supplied by a stream from the highlands above and by springs in its own depths. By reason of these springs its waters are usually cold. I plunged in on the deep side at one end, and swam strongly for about half the length of the lodge, side stroke. I stood up here in about 4 ft. 6 in. of water to listen to the watchman say that he was about to run the lodge dry, as a portion of the containing wall was giving way and required repairing.

I noticed here that the top and back of my head ached considerably, and that I was giddy. The giddiness did not alarm me, as I have felt giddy many a time after a prolonged swim on my back, and I know of similar experiences in others. I swam now in the opposite direction on my back, and at every stroke the headache became more severe, until it was almost unbearable. I assumed the breast stroke, and kept my head out of the water altogether, which somewhat mitigated the headache but during this time there occurred the strange part of my experience. I became very drowsy, muscular effort was feeble and sluggish, just like the slow movements of one half asleep, and, worst of all, a pronounced indifference to everything seemed stealing over me. In fact, I simply felt like letting my head fall forward and going to sleep. I slowly reached the bank, and after resting with a hold upon it for a short time I clambered out with considerable difficulty. I was in the water only for a few minutes, yet I felt chilled. The giddiness passed off shortly after dressing. I mounted my bicycle and slowly rode home, a distance of about a mile. I partook of a fair meal about 2 p.m., and as the headache persisted rather severely I lay down and directly went fast asleep. On awaking an hour later the headache was gone, and I felt as well as usual, so much so that I played and enjoyed two hours of hard tennis before 6.30 p.m.

This set of symptoms which I have endeavoured to portray is evidently connected with disturbance of the circulation of the brain, and is probably of an anaemic rather than a congestive nature. The vertigo suggests anaemia of the cerebellum and the cold water as the principal cause, since the colder the water and the longer the back of the head is under water—as, for instance, in swimming on the back—the more pronounced is the vertigo. The drowsiness, the sluggish muscular efforts and indifference to surroundings are probably to be ascribed to anaemia of the cerebrum, and are the precursors of complete unconsciousness. Hallucinations in respect to surroundings might conceivably have supervened upon the indifference followed by submersion and fatal consequences. To put it briefly, the swimmer simply loses consciousness from cerebral anaemia—in other words faints, goes under, and, but for immediate assistance, must inevitably perish. This explanation is probably nearer the truth than that with which we are so familiar at this time of the year—that is, “he was seized with cramp and sank.”

What are the causes that may be contributory to this end? Pathologically aortic disease and cardiac dilatation, either from obstruction or excessive beer drinking, are probably causes of the gravest importance, and no one suffering from any of these complications should ever risk himself in deep water. But, apart from disease, there are several other conditions not generally regarded as pathological which will contribute to death from drowning. I should instance as important in this category prolonged and severe muscular effort from racing, cycling, etc., even if followed by a short rest preparatory to swimming, and flatulent dyspepsia. Both of these circumstances may materially interfere with the heart beat—the one from exhaustion, the other from pressure; and when to those a plunge into cold water with a probable increased strain on the heart from swimming, together with the greater effort necessary in breathing, is added, the impulse of the heart may be so enfeebled as to fail in supplying the brain with the necessary quantity of blood.

In my own case—and I do not suffer from aortic disease or cardiac dilatation—probably the cycling together with the hot weather had produced a certain amount of exhaustion, although it was not perceptible to me when I entered the water. Besides, there was very little food in my digestive

system, for I had partaken of a very light breakfast, and, thanks or otherwise to a strong seidlitz powder earlier in the day, little or nothing remained of the previous day's food. I have noticed that one does not always experience the same comfort or pleasure after bathing, for some unexplained reason. Many a time I have seen swimmers and others emerge from the water looking ghastly and feeling rather sick and ill. Eructations are a great relief in those circumstances and are followed by marked improvement of all the symptoms. My stomach must have been empty of food, as it was over four hours since breakfast, but whether the stomach was distended with gas or not I do not at this moment remember, though I am willing to believe that there was an accumulation of wind.

CONCLUSIONS.

All those who are in the habit of swimming in deep water should from time to time submit themselves for medical inspection, even if they are supposed to keep themselves always in condition by uninterrupted swimming exercise all the year round. Especially is this important for those who indulge in open-air swimming only, during warm weather, perhaps restricted to the short summer holiday at the seaside. This class cannot have “worked up the necessary muscle,” to use a cycling phrase, for a prolonged swim, and any attempts at such a feat might easily result in disaster. By submitting to medical inspection any cardiac affection would be detected, while at the same time a suitable inquiry as to the state of the digestive system would elicit any facts pointing to atony of the stomach walls with consequent distension by gas. Atony of the stomach is usually associated with a general atonic state; and although cold bathing is eminently beneficial for this condition, any attempt at prolonged swimming is a positive danger.

It should be the duty of parents to ascertain if their children who are fond of swimming are perfectly sound and in good health, so that they might give the necessary restraining counsel to lads of daring, should circumstances demand it.

To enter the water with a full stomach is probably as dangerous as with an empty one, though this may be a matter for doubt. The happy mean, say about two hours after breakfast or lunch, is probably the best time to undertake a good swim. I should also certainly disapprove of swimming in cold water on any occasion in which the intestines had been emptied by a purgative and the circulation probably depleted thereby. In this instance we have a low-tension circulation, especially if accompanied by a fast of several hours, and sudden immersion might conceivably cause fainting with serious results. Instruction in what one might call the physiology of bathing should be considered indispensable to the members of every swimming club, and especially to all boys and girls who are learning the art. Suggestions, perhaps, rather than rules might be indicated which would prove serviceable for the purpose of instilling in the young a knowledge of the conditions favourable and unfavourable to indulgence in the exercise of swimming.

REMARKABLE CASE OF WOUND OF THE ABDOMEN, WITH PROLAPSE OF THE LARGE INTESTINE: RECOVERY.

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On Friday, May 26th, 1905, A. C., aged 59 or 60, was discovered lying on a footpath leading through a field of barley adjoining the Gibraltar Golf Club course at Campamento. He was apparently in a moribund condition, suffering from shock caused by a wound of the abdomen received in an affray; his clothes were blood-stained, and there was a cut in his trousers, on the removal of which a mass of intestine was found to be protruded through a wound in the left flank. There was some oozing of blood, and the clothes in contact with the bowel were anything but clean. The man was evidently very poor, and looked at least 70 years of age, and was nearly blind.

Assistance was sought at the Polo Club, situated about a quarter of a mile away, and a bed with a wire mattress was obtained from the village, and on it he was carried to the inn.

On arrival he was placed in an outhouse to which chickens and other animals had access. A surgical aid box was next procured from the Polo Club, which was some 300 or 400 yards off, and this was found to contain the following articles:

* A small reservoir common in this neighbourhood, and used for industrial purposes.