do not fall into any special clinical group, either with regard to otiology, cardiac enlargement, valvular involvement, or duration of the malady. Both successful and unsuccessful cases form heterogeneous groups.

The drug, quinidine sulphate, has a very remarkable action upon the auricle, and this action is of a potent nature. For this reason alone the method of direct leads from the chest is of importance, for it gives a record of the effect of the drug upon the auricle itself; the effect on the auricle will vary considerably owing to the factors of absorption, individual tolerance, etc., and the direct leads enable the drug to be controlled.

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THE MANNER IN WHICH QUINIDINE SULPHATE ACTS IN AURICULAR FIBRILLATION.*

BY

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THE action of quinidine sulphate upon the fibrillating auricle, an action but recently discovered, is perhaps one of the most remarkable and dramatic which is now known to therapeutics. The essential feature of the reaction is an invariable and conspicuous reduction of the rate at which the auricle beats; in patients in whom treatment is successful this progressive slowing of the auricular action is abruptly disturbed, the disordered action ceases, and the normal action is at once resumed.

To understand how these changes are brought about is of obvious importance; but this problem cannot be solved unless we are able first to understand the mechanism of fibrillation itself. Several views of the reaction of the fibrillating auricle to quinidine have been published, but as these all assume that fibrillation of the auricle is caused by rapid impulses, arising at one or more irritable centres in the muscle of the auricle, and to which the auricle responds in a confused manner, the explanations founded upon such an assumption remain inadequate. These theories of auricular fibrillation, until recently widely held, have undergone extensive revision, and are now scarcely acceptable.

Recently a series of papers² has been published from this laboratory, in which it has been shown that in auricular fibrillation a circus movement exists in the auricle; that a single wave is propagated and revolves perpetually upon a re-entrant path. The circus movement is repeated in the average 450 times a minute, and it is this circulating wave which, in its revolution, alone controls the beating of the auricle. The auricle is no longer controlled by discrete impulses arising at a single point on the auricular muscle, each impulse originating a corresponding discrete wave of contraction in the auricle which dies away and is renewed, but by a never-ending wave which passes over and over again through the same muscular channels. To understand the action of quinidine it is necessary to understand the factors which control this circus movement. They have been stated previously, and are: (a) the length of the path followed; (b) the duration of the refractory period at any given point; and (c) the speed at which the wave is conducted.

Circus movement in the auricle is only possible (1) if a circular path of sufficient length is available; (2) if the refractory period is sufficiently short; and (3) if the speed at which the wave moves through the muscle is sufficiently slow. Otherwise the crest of the advancing wave in re-entering muscle through which it has already passed will discover this muscle to be still refractory and will be unable to proceed. The wave in travelling leaves muscle behind it which is for some time incapable of response; time must elapse to permit recovery before the new or

re-entrant wave can again pass. Quick recovery (a short refractory period) clearly favours re-entry; so does a long path, and so does a slow rate of travel, for the two last conditions both delay the arrival of the re-entrant wave.

Now experiment has shown us that in auricular fibrillation the gap between the crest of the advancing wave and its wake is very small; on the circular path, the wave is always advancing through muscle which has but just recovered its excitability; the presence of some gap is all-essential, upon its existence the continued movement absolutely depends. It has been stated that if we could find a remedy which would close this gap, either in flutter or in fibrillation, the circus movements to which these abnormal movements of the auricle depend, would at once cease. The first of such remedies has been discovered in quinidine.

Hoffmann¹ in observing the effects of quinidine experimentally found that it reduces the excitability of the auricular muscle; that is true, but it was not made clear by his experiments how this reduction happens, neither is a reduced excitability in itself a sufficient explanation of the remarkable effects of quinidine on the fibrillating auricle. In recent experiments, a full report of which will be published elsewhere, we have found that the most striking action of quinidine upon the auricle is a lengthening of the refractory period; the lengthening which occurs, when doses comparable to those used clinically are employed, amounts to 50 per cent. or more. The reason why quinidine brings fibrillation of the auricle to an end seems to us therefore not to be in doubt. It prolongs the refractory period of the auricle and delays the recovery of the tissue, thus rendering the gap between the crest and the wake of the circulating wave shorter and eventually abolishing it altogether; when the last event happens the abnormal action of the auricle ceases and the normal impulses are thus enabled once again to resume control.

Though we do not doubt that this is the explanation of the successful treatment, the problem is not quite so simple as it may at first seem; for quinidine has not only this action upon the refractory period, it has further actions. The most important of them from our present standpoint is an effect on the rate of conduction; it slows conduction in the auricle. Now slowing of conduction favours re-entry; it prolongs the gap. Thus quinidine exerts two effects which, so far as circus movement is concerned, are opposed to each other; on the one hand, by prolonging the refractory period it tends to shorten the gap; on the other hand, by slowing conduction it tends to lengthen the gap. It is only in those cases where the first effect predominates over the second that the gap will close and the circus movement will terminate. In patients suffering from chronic auricular fibrillation the first effect appears to predominate in approximately 50 per cent. of the cases, for in this percentage auricular fibrillation is abolished; in those patients (the remaining 50 per cent.) in whom this desired end-result is not obtained, it would seem as if the second effect predominates, or that the opposed effects are exerted equally. It is to be noted that in patients in whom fibrillation is not abolished there is nevertheless slowing and usually very profound slowing of the auricle, the rate falling from its original rate of 400, 500, or 600 per minute to 300, 250, or even 200 per minute; such slowing would be the anticipated effect of depressed conduction in the auricle, and it is probable that it is to be ascribed to this cause, in the main, at all events.*

The theory of fibrillation which we support—namely, its dependence upon circus movement—is one which, in the light of our recent experiments upon quinidine, is fully competent to explain the remarkable action of this drug upon the disorderly action of the auricle under consideration. We publish this note at the present time to draw attention to our view of the manner in which quinidine acts, believing that treatment by means of quinidine, which is now engaging the attention of many workers, is best controlled when its action is interpreted in the way which we suggest, and that further progress in this method of treatment, already highly successful, promises to come

* Another factor—namely, lengthening of the path, the wave seeking a new and longer path of re-entry as it finds the old one closed—possibly contributes; but we do not at present regard it as the main factor. It is also to be noted that quinidine very probably affects what we have termed the partial refractory period, and some evidence in this direction has been obtained. But these factors, at present regarded as minor ones, are as yet unripe for discussion.

* Being a preliminary account of work undertaken for the Medical Research Council.

from a consideration of those factors which we here discuss. At the same time it may be wise to utter a word of warning against the indiscriminate and uncontrolled use of this powerful remedy. It is a remedy of which we still have much too little knowledge; it is one which, unless it is strictly controlled by frequent records of the auricular and ventricular action, is not without serious risk. The time will no doubt come when its use in general practice may be advocated; but it has not yet come.

A phenomenon which not uncommonly disturbs treatment is a rise of ventricular rate; this rise of ventricular rate is almost invariable as the heart comes under the influence of quinidine. Experimental work goes to show that this rise may be due to two causes, acting probably together. A fall of auricular rate is itself sufficient to produce a lesser grade of block and a resulting rise of ventricular rate. But we find that quinidine has a paralysing action on the vagi, an action not altogether unlike, though less powerful than that of atropine; by reducing vagal tone the drug will increase the power of the junctional tissues to conduct, and lift the ventricular rate, as does atropine. Opposed to these actions is a direct action of the drug upon the junctional tissues; this has been shown by several workers,^{3,4} and we can fully confirm it. This opposed action probably moderates in some measure the rise of ventricular rate which occurs during the clinical use of quinidine in cases of auricular fibrillation.

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ENLARGEMENT OF A SPLENCULUS TO THE SIZE OF A NORMAL SPLEEN

AFTER REMOVAL OF A RUPTURED SPLEEN
TEN YEARS PREVIOUSLY.

BY

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AND

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ON May 24th, 1910, Mr. R., aged 21, while playing football in Kuala Lumpur, Federated Malay States, collided with another player, and in doing so received a violent blow over the splenic region. He felt somewhat faint, but continued playing for about twenty minutes. He then began to feel much worse, complaining of pain in the abdomen, particularly in the left upper area. Faintness increased and he vomited once. The accident occurred about 6 p.m., and he was admitted to the European Hospital at 8 p.m. On admission, he was very pale but without an anxious expression; pupils widely dilated; pulse very weak and thready, 95 per minute. On examination of the abdomen there was dullness over the splenic region and for about a handbreadth below the left costal margin and in the left loin. Tenderness was observed over the epigastric and splenic regions. Liver dullness present. At 10 p.m. the patient was somewhat restless. The dullness over the spleen and liver had given way to a tympanitic note. The pulse was still feeble, and had increased to 100 per minute. He was then operated on by Dr. G. D. Freer, with the assistance of Dr. John Gray.

The abdomen was opened in the middle line over the epigastrium. The peritoneal cavity was found to contain blood, and on the spleen being examined it was seen that it was torn on the inner side in the region of the hilum. The incision was enlarged, and a transverse cut made towards the left, dividing the left rectus muscle. The whole spleen was then removed after the pedicle had been secured with a double ligature, a number of forceps having been applied for safety before the pedicle was severed.

That the actual spleen was removed is proved by the following evidence. It was weighed by Dr. J. P. Masters and found to be 13 oz., a normal spleen weighing in the adult about 7 oz. The patient had apparently contracted malaria previously to the accident, and the enlargement of his spleen may have contributed to the ease with which it was ruptured. Dr. John Gray, who helped at the operation, says in a letter to one of us (W. McA. E.), "the spleen was

completely removed." Miss A. McBride, who was sister in the theatre at the time of the operation, writes: "I saw the operation . . . the spleen was removed," and Miss H. M. Shaw, a nurse who was assisting in the theatre, writes: "I was busy during the operation with keeping a supply of hot water and saline ready, so I cannot say that I actually saw the spleen removed, but I heard the remarks made when it was out, and I went to the laboratory the next day and saw it."

The patient made a somewhat complicated recovery, having what was thought to be mild malaria, and some trouble at the base of the left lung. He was discharged from hospital on July 5th, 1910. On that date an examination of the blood showed—red cells, 4,800,000; haemoglobin, 75 per cent.; leucocytes 9,000, with polymorphonuclears 51 per cent., lymphocytes 8 per cent., large mononuclear 31 per cent., and eosinophiles 10 per cent. It was stated by Dr. A. T. Stanton, of the Institute for Medical Research, Kuala Lumpur, who made the examination, that the somewhat low colour index, slight leucocytosis, with relative increase of large mononuclear forms (? a souvenir of malaria) and of eosinophiles, are the only features worthy of remark.

A further blood examination was made by Dr. Stanton on August 10th, 1910, five weeks later, and the red cells numbered 5,600,000; haemoglobin, 90 per cent.; leucocytes 7,000, with polymorphonuclears 44 per cent., lymphocytes 26 per cent., large mononuclear 15 per cent., and eosinophiles 15 per cent.

On full recovery the patient was able to carry out his duties in the Malay States without any untoward symptoms, and states that he was assured that he would not suffer again from malaria as he was minus his spleen! He continued in good health for eight years, after which he began to have some attacks of weariness, and was found to have an evening temperature. It was considered by his medical advisers that this might be due to some obscure form of tubercle.

Early in 1920 his general condition was in no way improved, and he was losing weight. With this the ventral hernia, which had been gradually developing at the site where the left rectus had been cut through, became much increased in size, and caused considerable inconvenience. It was decided that he should come to England for advice. He came via the Cape of Good Hope, and on arrival, after a journey of four months, was considerably improved, having lost his temperature and gained flesh.

He was sent to one of us (W. McA. E.) by Dr. Marcus Johnson with a view to the cure of his traumatic hernia. On examination it was found that in general health he appeared well, was not anaemic, and had no temperature. There was a wide gap in the upper third of the left rectus, and on coughing a marked protuberance of abdominal contents took place. It was decided to attempt a cure by operation.

On September 4th, 1920, ether was administered by Dr. C. F. Hadfield, Mr. W. Girling Ball acting as Mr. Eccles's assistant, the matron of the nursing home and the theatre sister also being present. On opening the abdomen some adhesions of omentum were found and separated. Then, to the astonishment of all present—and each one of five persons confirms the fact—a well-formed, normal-looking spleen was seen in the usual position.

Knowing the previous history, the organ now found was fully examined. It was taken in the hand of Mr. Eccles, drawn forward, found to have a definite pedicle in which could be felt pulsating vessels. The shape, size, notch, colour, and consistency all appeared to be that of a normal spleen. Each person present was requested to look well at the organ, and all agreed that it appeared to them to be a normal spleen. The left kidney region was then examined and a normal left kidney palpated. A radical reparative operation was performed upon the gap in the left rectus and the abdomen closed. The patient made an uninterrupted recovery, the hernia remaining cured up to the time of this record.

That a splenculus may enlarge, after the removal of an ordinary spleen, is well known, but the rarity with which such an enlarged organ is actually seen during life makes it desirable to place this case on record.

THE next French Congress of Psychiatry will commemorate the tercentenary of François Bayle, born in 1622.