The Schorstein Lectures

ON AURICULAR FIBRILLATION.

DELIVERED AT THE LONDON HOSPITAL,
OCTOBER, 1911,

BY

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LECTURE II.

In this lecture I propose to deal with the subject of auricular fibrillation from the point of view of the practical physician, discussing the manner by which it may be recognized, its prognostic significance, and its treatment. Before dealing with the more common methods of clinical examination I shall refer shortly to the main features which are detected by graphic and electrocardiographic records.

the fibrillating auricle. They are not present in every case, nor always perceptible in those cases that show them. When present, they are most evident during those long pauses of the ventricle which are so frequent in auricular fibrillation. These fibrillation waves are of a variable size, sometimes very minute, as in Fig. 12, and sometimes very coarse, as in Fig. 13. In Fig. 15 they will be found to vary in size and duration at different times.

I have already dwelt on the difference between tracings taken before and after the onset of fibrillation, and Figs. 14 and 15 show this difference in a case recently under observation. This patient had repeated attacks of paroxysmal tachycardia, due to auricular fibrillation. The last attack did not pass off. Fig. 14 was taken in February, 1911, and Fig. 15 in June, after the auricular fibrillation had persisted for two months. It will be observed that in Fig. 14 the rhythm is perfectly regular, and preceding the wave *c* there is an auricular wave, as in all normal acting hearts.

The Evidence from the Electrocardiogram.

The contraction of each chamber of the heart gives rise to an electrical discharge. This discharge can be con-

Fig. 12.—Tracing from a case of auricular fibrillation with heart-block, showing small fibrillation waves. The rhythm is regular and the rate about 30 per minute, and the jugular pulse is of the ventricular form.

The Evidence from Graphic Records.

I have already dwelt upon the important part that graphic records have played in throwing light upon auricular fibrillation, and I have pointed out that all

Fig. 13.—Tracing from a case of auricular fibrillation, showing coarse fibrillary waves (*f*).

signs of an auricular wave disappear from the apex beat and the jugular and liver pulses, and that these pulses change at the onset of auricular fibrillation from the auricular form to the ventricular. It may be taken as

deduced from the body to a string placed between the two poles of a magnet. The electric currents produced by the contraction of the auricle or ventricle cause deflections of this string. By a suitable arrangement the movements of

Fig. 14.—Tracing from a case with mitral stenosis, with a normal rhythm. (Compare with Fig. 15.) (February, 1911.)

the string are projected on to and recorded by a moving photographic plate. The records thus obtained show variations of a very definite and characteristic kind, which can be recognized as due to the contractions of the

Fig. 15.—Tracing from the same patient as in Fig. 14. Auricular fibrillation is now present and the rhythm is irregular. The venous pulse is of the ventricular form, and there are fibrillation waves (*f*) during the long pauses. (June, 1911.)

established that when we get a continuously irregular pulse with the ventricular form of venous pulse we have proof of the presence of auricular fibrillation.

There is an additional feature, which is also of value in recognizing the presence of auricular fibrillation, and that is the presence of the small waves caused in some way by

chambers of the heart. In the normal acting heart there is a peak (*P*) which is due to the auricle. This is followed by a series of movements, but we need only concern ourselves here with the elevations *r* and *t*, which are characteristic features produced by the ventricular contraction (Fig. 16).

While the normal electrocardiogram shows features similar to those in Fig. 16, a great number of differences can be obtained, each due to some abnormal action of the

Fig. 16.—Electrocardiogram of a heart with the normal rhythm. The elevation P is due to the auricle, and the summits R and T are due to the ventricular systole (Lewis).

heart. So far as the electrocardiogram of auricular fibrillation is concerned the records show some very characteristic signs, the chief being a total disappearance of the peak, P, due to the auricle (Fig. 17). The variations R and T, due to

Fig. 17.—Electrocardiogram from the same patient as Fig. 16, taken during an attack of auricular fibrillation. The elevation P is absent and there are small waves (f) due to the fibrillation of the auricle (Lewis).

the ventricle, maintain their characteristic form. Between the ventricular beats the records may show a series of small movements, which we now recognize as being due to the fibrillating muscle of the auricular wall. This absence of the auricular movements and the presence of the movements during ventricular diastole are the means by which auricular fibrillation can be recognized in the electrocardiographic record. Further, there is also the characteristic disorderly rhythm. Figs. 16 and 17 were taken from the same individual—Fig. 16 when the rhythm was normal, and Fig. 17 when there was present a transient attack of auricular fibrillation.

Clinical Characteristics.

The Patient's History.—The conditions which induce auricular fibrillation vary, but there are two classes among whom it is very frequent—namely, patients with a heart affection following upon rheumatic fever (frequently associated with mitral stenosis), and elderly patients with fibrous degenerative changes, usually spoken of as "senile." It is customary in rheumatic hearts to take into account only the valvular changes, while as a matter of fact the really serious element is the slow, insidious change in the muscle that has started during the attack of rheumatic fever, and which finally provokes fibrillation of the auricle.

The Patient's Sensations.—Many people become conscious of the heart's action when it departs from its normal rhythm. Thus, extrasystoles are sometimes recognized by the individual's consciousness of the long pause or of the big beat which follows the pause. The patients liable to paroxysmal tachycardia are conscious of the attack by the feeling of a gentle fluttering sensation in the chest. When the attacks of tachycardia are due to auricular fibrillation this fluttering is also present, but usually it is not a continuous fluttering sensation but is interrupted by thumping sensations, due to the occasional occurrence of bigger beats. This consciousness of the heart's action is frequent in cases of auricular fibrillation, the patients being conscious of the fluttering and thumping action of the heart. In many cases where the heart does its work efficiently these sensations are not perceived unless the heart is submitted to over-exertion, or when it begins to fail.

Character of the Pulse.—The symptom by which the clinical observer can most readily recognize this condition is by the character of the pulse, the rhythm usually being irregular, and the irregularity of a very disorderly kind. Irregularities, apart from those due to auricular fibrillation, usually have a distinctive character, as the irregularity in the heart of the young, where variations in rate coincide with phases of respiration, as the intermittent pulse, or the irregular heart due to extrasystoles, the irregularity breaking in on an otherwise regular rhythm, unless it occurs alternating with a normal pulse beat. In auricular fibrillation, as a rule, the pauses between the beats are continuously changing, and two succeeding beats are rarely of the same strength, or the pauses between the beats of the same duration. The character of the irregularities will be better recognized from the radial tracings in Fig. 18. These tracings were taken from five patients, and it will be found that the duration of the beats is always varying and that the rhythm is quite disorderly.

Changes in the Heart's Murmurs.

I have already dealt with the evidences of auricular activity obtained by graphic and electrocardiographic

Fig. 18.—Radial tracings from five patients with auricular fibrillation, showing the disorderly nature of the heart's rhythm.

methods. The evidence of auricular activity obtained in the clinical examination, apart from the inspection of the jugular pulse, is limited to cases with mitral stenosis. We must bear in mind that stenosis of the mitral valve is a gradual process, at first not recognizable until a certain degree of narrowing has arisen. This narrowing obstructs the flow of blood from auricle to ventricle, and gives rise to a murmur on the contraction of the auricle. The presence of a presystolic murmur is usually an indication not only of an obstruction to the flow of blood from auricle to ventricle, but also of gradually progressing fibrotic changes in the valves and around the mitral orifice. With progressive narrowing the presystolic murmur becomes louder and longer, while a new murmur may appear after the second sound. This diastolic murmur is due to the obstruction of the flow of blood through the mitral orifice at the end of ventricular systole. It is faint and short at first, but with further narrowing of the mitral orifice it increases till it fills up a great portion of the diastolic period of the cardiac revolution, and may run up to the presystolic murmur. When this happens the diastolic period is filled up entirely by murmurs. We may take it that the appearance of this diastolic mitral murmur is always an evidence that the progressive narrowing of the mitral orifice has reached an advanced stage. But the fibrotic changes that cause mitral stenosis are not limited to the valvular orifices, but are also present in the muscular walls of the heart. These changes in the auricular wall predispose to auricular fibrillation, and this may arise at

different stages. With the onset of fibrillation a change takes place in the character of the murmurs.

If a presystolic murmur due to the auricular systole was present prior to the onset of the fibrillation it at once disappears when the pulse becomes irregular. If a diastolic murmur due to mitral stenosis has been present it persists, because it is caused, not by the systole of the auricle, but by the inrush of blood from the auricle into the ventricle when the ventricle relaxes after its systole. I wish to emphasize this change in the character of the murmurs in mitral stenosis with auricular fibrillation, for even those who detect the clinical symptoms of auricular fibrillation do not seem to have grasped the significance of the change in the murmurs. I have carefully studied a large number of cases of mitral stenosis with fibrillation, and many of them have come to an autopsy, and in none of them have I detected a presystolic murmur of the crescendo type. Where a murmur has preceded the first sound, it has filled the whole diastole when the rate was rapid. When the heart's rate is rapid in auricular fibrillation, this diastolic murmur often fills up the whole space between the second and first sounds, and it may simulate, and is often taken for, a presystolic murmur due to the systole of the auricle. If, however, this murmur be noticed during one of the long pauses, which occur frequently in most cases, or when the heart's rate becomes slow, it will be found that this murmur follows the second sound, but pauses some little distance before the first sound, and there is a silence immediately before the first sound in the place where the crescendo presystolic murmur due to the auricle should appear.

This is brought out in the diagram in Fig. 19, where

Fig. 19.—Diagram to illustrate the change in the murmurs that arise in cases of mitral stenosis when auricular fibrillation sets in. The downstrokes 1 and 2 represent the first and second sounds of the heart, and the shading between the second and first sounds represent the diastolic and presystolic murmurs (A) with a regular rhythm. In B auricular fibrillation causes the rhythm to be irregular, and when the diastolic period is short, as at x, x, x, the diastolic murmur fills up the whole interval. When, however, the diastolic period is lengthened, as at y, y, the diastolic murmur does not fill up the whole period, and there is then a silence before the first sound where the presystolic murmur was before fibrillation set in.

A and B represent the sound and murmurs in mitral stenosis before and after auricular fibrillation. In B it will be seen that there is no presystolic crescendo murmur and that the diastolic murmur fills up the whole of the space between the second and first heart sounds when the interval is short (x, x), but when the interval is long (y, y) the diastolic murmur does not reach the first sound, and there is a silence before it.

From these considerations, we can in the great majority of cases conclude that auricular fibrillation is present when there is a diastolic mitral murmur without a presystolic murmur. As a rule, the irregular action of the heart is also suggestive, but in many cases of mitral stenosis with auricular fibrillation, when the patient is under digitalis, the heart becomes slow and almost, or even quite, regular. The fact that the auricle is fibrillating is the explanation of the observation which has puzzled many physicians in the past, that in mitral stenosis a presystolic crescendo murmur may be absent while a diastolic murmur persists.

Symptoms of Heart Failure.

While these are signs by which we may detect the presence of auricular fibrillation, it is usually the signs of heart failure which attract attention. These signs, however, are not peculiar to or characteristic of auricular fibrillation, but are common to heart failure induced by other conditions. These signs of heart failure may range

from a slight breathlessness on exertion to dyspnoea of the most severe kind, accompanied by dropsy, enlarged liver, and the symptoms associated with extreme heart failure.

As a rule, the onset of symptoms of heart failure is slow and gradual, due in a measure to the individual's persisting in living in his usual manner though the heart is hampered by the abnormal action. On the other hand, the onset of heart failure may be very rapid. Within a few hours of the occurrence of auricular fibrillation, the distress of the patient may be very severe, the countenance dusky, the heart dilated, orthopnoea, and a feeling of distress is experienced. I have seen these phenomena arise rapidly in cases where the fibrillation occurred intermittently, and the relief experienced by the patient when the heart resumed the normal rhythm was as remarkable and striking as the onset of the suffering. At once the patient knows that the heart's action has altered, and he breathes easier, and the feeling of distress disappears. Within a few hours the heart and liver have become reduced in size, the lividity of the face has gone, and the tenderness of the chest wall and over the region of the liver speedily disappears.

In many cases the onset of heart failure is accompanied by wasting, the patient sometimes losing a good deal of weight in a few months. Accompanying this there is usually a certain amount of flushing of the cheeks, usually of a dusky colour, and occasionally a slight sallow tinge of jaundice.

Amongst the more common signs of heart failure there is one which I have not seen—namely, definite attacks of angina pectoris. As I have already stated, pain and hyperalgesia are not uncommon in the heart failure associated with auricular fibrillation, while I have never met with typical attacks of angina pectoris in these cases, with one doubtful exception. In quite a number of cases where the patient had angina pectoris, the attacks ceased with the onset of the fibrillation. Needless to say that the onset of auricular fibrillation in those cases induced such embarrassment to the heart's action that the patients all drifted, and only lived a few months after its onset.

Prognosis.

We must bear in mind that auricular fibrillation is in reality a symptom of some myocardial change, and that, to be logical, we should only consider it from the point of view of a myocardial affection. We are at present so ignorant of myocardial disease that we are forced to put one symptom forward as if it were in itself a disease. Illogical as this seems, it has its use, for the occurrence of auricular fibrillation induces such a profound change in the heart's action, affecting its efficiency, reacting on the ventricle, and modifying its behaviour to drugs, that we are compelled to look upon it as a condition apart. Considering the variety of conditions that induce auricular fibrillation, it is difficult to state briefly its prognostic significance. In referring to the pathological lesions associated with it, I showed that they were of a very diverse kind in nature and in degree. It is in all probability the extent of these pathological changes which determines the prognosis of auricular fibrillation, and an attempt should be made to estimate their extent. If we look upon the inception of the new rhythm as in itself embarrassing the heart in its work, then the maintenance of an efficient circulation depends on whether the heart is able to do its work when hampered by the new rhythm. That this is the fundamental question will be recognized when we study the effect of fibrillation in certain individuals. I have repeatedly seen individuals in whom fibrillation occurred for a short time, and in whom heart failure set in with an extraordinary rapidity, the patient becoming breathless, having to sit up in bed, the face becoming livid, the heart dilated, and the liver swelling, within a few hours after the onset of fibrillation. With the restoration of the normal rhythm these symptoms quickly disappeared. When fibrillation became permanent in such individuals the signs of heart failure persisted sometimes in spite of all treatment, till death supervened in a few weeks or a few months.

On the other hand, I have repeatedly seen fibrillation set in and the individual be altogether unconscious of its presence. These cases may go on for years with little inconvenience; but the majority after some years gradually show signs of a limitation of the field of

cardiac response, and their future depends upon how they respond to treatment and on their ability to diminish the amount of their bodily work and to live within the limits of the heart's strength.

Much more frequently there is a considerable limitation of the heart's power of response to effort, and if the usual life of the individual be pursued, without appropriate treatment, there is a great tendency for the heart gradually to fail. There is no doubt that the onset of fibrillation can lead directly to a fatal termination, or, rather, can be associated with conditions that lead to death. Thus, one of my patients died suddenly forty-eight hours after the inception of auricular fibrillation. Another one fell down dead six months after its inception. I have seen a number of other patients die suddenly who had auricular fibrillation, but some of these suffered from a considerable degree of heart failure. It has appeared to me probable that in these cases the ventricle has passed into fibrillation, as McWilliam suggested. This view is probable also from the fact that the histological changes in the ventricle were similar to those in the auricle in some of the cases of sudden death.

The usual mode of death in auricular fibrillation is a steady advance of the heart failure, as shown by the breathlessness on exertion, orthopnoea, dropsy, and enlargement of the liver, etc., sometimes with an absolute failure of response to all forms of treatment. Thus, I have seen death ensue in this manner a few weeks after the inception of fibrillation, and others have drifted on for a few months, while some have led a somewhat chequered career for a number of years, seldom fit for much bodily exercise.

In giving a prognosis in cases of auricular fibrillation it is necessary to appreciate a good many other things besides the mere presence of the fibrillation. It is necessary to form an opinion of the extent of the changes that have led up to the fibrillation, and in many cases to find out how long these changes have been going on; as, for instance, the date of an attack of rheumatic fever; and how the patient comported himself before the onset of fibrillation; if, for instance, he was liable to attacks of heart failure, in which case such attacks point to a tendency to exhaustion which may be aggravated by the fibrillation. In addition, the character of the murmurs present in mitral stenosis will shed light upon the progress. When auricular fibrillation sets in, it is necessary to observe the accompanying changes in the heart and the way in which it maintains the circulation. Thus, an increase in the size of the heart, or a rate over 120 beats per minute, usually leads to a speedy exhaustion of the heart's strength. I have occasionally met with a case with a heart-rate of 100 and 120 per minute, with no increase in the size of the heart, who suffered little inconvenience; but as a rule any rate over 90 beats per minute tends to induce dilatation and consequent exhaustion. On the other hand, when there is little increase in rate, or even when the rate is somewhat slower than normal and the response to effort good, the prognosis is usually very favourable.

In those with symptoms of manifest heart failure prognosis depends to a great extent on the way in which they respond to treatment. I have already described the action of drugs of the digitalis group in patients with fibrillation, and I will show later more fully the action of drugs in these cases, and the response of the heart to them, and what an important bearing it has upon prognosis.

I have already said that there are a great many individuals with fibrillation who lead useful and energetic lives, and whose capacity for work is little, if at all, impaired by the new rhythm. In such the prognosis is distinctly good.

There are, however, so many exceptions to these details that a clearer insight may be gained by looking at each case from a broader standpoint of how the heart responds to effort, not, however, ignoring the details, but giving them their due consideration. It is in estimating this reserve power that we get the most valuable information. It may be taken for granted that if distress is induced by exertion, so long as the exertion is persisted in, it will ultimately lead to serious heart failure. On the other hand, when individuals with fibrillation are able to under-

take the work equal to that done by a perfectly healthy man, there is proof of such a degree of healthy heart muscle and freedom from valvular or muscular embarrassment that a good prognosis can be given.

We meet, however, with such varying degrees of exhaustion, that an estimate must be acquired of the amount, though it is impossible to describe with accuracy what that amount may be. Even with distinct limitation of the heart's power, as shown by the response to effort, the prognosis may still be favourable, so long as the patient lives within the limits of his powers, avoiding such efforts as cause him distress or exhaustion.

In transient attack of auricular fibrillation the attacks usually tend to become more frequent, until auricular fibrillation becomes permanently established. The prognosis of such cases depends on the way the circulation is maintained, this to be estimated in the manner already described. Transient attacks may appear for a short period and then disappear entirely. In two of my cases I detected a transient attack of auricular fibrillation twenty years ago, and the patients still lead vigorous and active lives. From the recognition of such cases we can conclude that auricular fibrillation is not of necessity a sign of extreme damage.

A most valuable aid in prognosis may be found in observing how the patient responds to treatment. In sudden attacks of severe heart failure, when the heart's rate is over 120 per minute, it will be well to suspend judgement until the reaction to digitalis is found out. Many such cases respond speedily to digitalis, and with the resultant decrease in the heart's rate a remarkable degree of recovery may ensue, so that the patients may be able to undertake laborious work so long as the rate is kept down by the digitalis. This would seem to imply that the exhaustion is mainly brought about by the ventricle being stimulated to too great an activity, and that the slowing enables the ventricle to get more rest, and so regain a measure of strength. From this result, we can also gather that the ventricular muscle must be fairly healthy, and we can estimate, within certain limits, the amount of healthy muscle by the degree of recovery.

Treatment.

General.—When any individual with heart failure presents himself for treatment, it may be taken for granted that the individual has been undergoing a greater amount of exertion than the heart has been competent of performing. Hence the exhaustion of the heart's strength has been brought about in the first place by overwork. It may be that the amount of work has been small, as measured by what a healthy heart can perform, but when a heart is hampered by an inherent defect, such as auricular fibrillation and the organic changes in the valves and muscle so commonly associated with this condition, the heart may be capable of a very limited amount of effort. With this conception of the cause of heart failure, the first and obvious course to pursue is to ease the heart of its work. In doing this much discrimination is required, and a thorough inquiry into the patient's mode of life has to be made in order to find out what circumstances, such as overwork, sleeplessness, digestive trouble, pain or work, may have provoked or aggravated the heart failure. These have to be attended to in every case, and relief may be at once afforded with the removal of the disturbing or exhausting cause.

The Use of Digitalis.—While it is important to attend to such circumstances in heart failure with auricular fibrillation, as in all other forms, there are circumstances in cases of heart failure with fibrillation which when appreciated help greatly, not only in the restoration of the heart's strength, but in the prevention of heart failure. I have already dealt with the reaction of hearts affected with auricular fibrillation to digitalis from a physiological standpoint; it is in treatment of auricular fibrillation that we find the great value of this drug, and I cannot speak too highly of its therapeutic action.

It is seldom that I have been able to say that I have saved a patient from immediate peril by the use of drugs, but this I can say with confidence, that I have repeatedly seen patients in evident peril of death removed rapidly from danger and restored to a condition of comparative health and fit for work by the judicious use of digitalis. The manner of its application needs, however, very careful

attention, for it is a drug that needs to be applied on certain definite lines, if full benefit is to be obtained from its action. I think it necessary to insist upon this point, for the somewhat "rule-of-thumb" methods of its use so generally employed fail to get the full amount of benefit which this drug is capable of bestowing.

To understand the action of digitalis it is necessary to appreciate the manner in which heart failure progresses in cases of auricular fibrillation, and the way it is controlled by digitalis. It may be taken for granted that when a patient with auricular fibrillation has a pulse-rate, or, to be more accurate, a ventricular rate, of 90 beats per minute and over, he will in course of time gradually lose strength, his heart will become more feeble, and evidences of heart failure will gradually supervene. This process may be very gradual, but it is very sure. On the other hand, heart failure may set in rapidly, more especially when the heart's rate rises to 120 and 140 and over. The severity of the failure, however it is brought about, compels the patient to seek rest, and we generally find such patients in bed, sitting up and breathing in a laboured fashion, with considerable distress, the heart usually dilated and the face of a bluish tinge, and possibly with dropsy and pulsation of the liver. In all such cases the prompt administration of digitalis is urgently called for, and, if given in sufficient doses, relief may be obtained in a few days, the relief being accompanied by a remarkable slowing of the pulse-rate. When this is accomplished, the digitalis should be stopped for a few days, and resumed in small doses when the rate begins to increase. The rate of the pulse should be watched, and the quantity sought for which keeps the heart under 70 beats per minute. It is seldom advisable to keep the rate under 50 beats per minute, although in some cases the patient feels fittest when it is at a rate of about 50 beats per minute. In this we must be guided by the patient's sensations and the manner in which he responds to effort.

Even when patients suffer from only a moderate degree of heart failure, and are able to go about, it is well to place them under the influence of this drug if the pulse-rate is over 90 beats per minute, and in some cases if it is over 80 per minute. My usual procedure in such cases is to attend to any circumstance that may aggravate the heart failure, and then to give the patient digitalis until the pulse-rate is reduced. If the failure is of some severity, I put him to bed until the proper effect is obtained, but where it is less in degree I permit him to go about his affairs.

In all cases where the heart has been sufficiently reduced in rate I find out the quantity of the drug that is necessary to keep the heart at the rate at which it can perform its work with the greatest efficiency. In doing this the patient's sensations are of the greatest help, whether he is confined to bed or attending to his affairs. They readily appreciate the change in their response to effort, and some such symptom as a disagreeable action of the heart or breathlessness can be employed as an indication that the heart's strength is being exhausted. Once the patient understands the meaning of these sensations, he is usually quick to perceive what digitalis does for him, and its administration can usually be left quite safely in his hands. On such lines I have seen many people lead useful lives for long periods of years with no bad effects, except when they have not taken the drug in sufficient quantities to keep the heart at the required rate.

The foregoing line of treatment is applicable chiefly to cases in whom auricular fibrillation has arisen recently or where the heart failure is of recent date. In more advanced cases, when the condition has induced from time to time periods of heart failure, and there has appeared the change that accompanies chronic heart disease, such as persistent shortness of breath, enlarged liver, and dropsy more or less continuous, the persistent use of digitalis may still tend to restore a measure of strength to the heart and give relief, enabling the individual to lead a useful life, though at a lower level, for an indefinite period.

In the search for an appropriate line of treatment in old-standing cases, I have used many methods and many drugs, often with little or no benefit, but in a certain proportion of apparently hopeless cases I have seen extraordinarily good results following the use of digitalis,

pushed until a reaction was obtained, and then stopped for a time, and again resumed, time after time. Not infrequently after it has seemed useless to continue the drug, I have seen the individual acquire such an amount of strength as would scarcely have been anticipated.

As the conditions preceding auricular fibrillation and producing it are all due to changes in the heart muscle, of a slowly progressive nature, it is easy to recognize that the heart's strength cannot always be restored, and that as the amount of efficient muscle becomes reduced, a period is reached when no method of treatment is of avail.

Method of Administration.—A great diversity of opinion is to be found in regard to the form in which digitalis should be given, and also in regard to the dosage. So far as I have worked out the subject in regard to auricular fibrillation, I see no reason for giving the preference to any particular preparation. The best and most assured way, in cases of marked failure, is steadily to push the drug, whichever form be employed, until a reaction is observed. Usually the digestive system is the first affected, loss of appetite, nausea, vomiting, or diarrhoea being set up, the patient usually feeling ill and miserable. If the digitalis is effective on the heart, as a rule a marked slowing of the pulse is found at the same time, or even before any digestive disturbances arise. In some cases a slowing of the pulse is the first sign of a sufficiency. When this stage is reached I always stop the administration of the drug for a few days. In a day or two the feeling of nausea passes off, and patients feel remarkably well and bright. The pulse-rate is carefully observed, and when the rate shows signs of increasing half-doses of the drug should be given, and the dose increased or diminished according to the manner in which it affects the pulse-rate, the object in view being to give just the amount which enables the heart to carry on its work with the greatest efficiency. As I have previously stated, the patient himself by his own sensations speedily acquires the knowledge of how much of the drug is needed, and by attending to his own experiences he will soon find out the smallest dose which is needed to give the best results.

A good deal of my work has been done with the tincture of digitalis, and I may say that I have used this preparation for over thirty years, and have never yet come across an ineffective preparation, my standard being the reaction in susceptible individuals. Professor Cushny has tested experimentally a number of samples from the Mount Vernon and this hospital, and has found each sample effective.

The quantity I usually start with, where the failure is marked, is 1 drachm of the tincture per day, in doses of 15 to 20 minims. This is steadily pushed until a reaction is obtained; then it is stopped and employed in the manner already described. Usually a reaction is obtained within a week, sometimes in a few days. Where there is great distress and more urgency I give as much as 2 drachms of the tincture daily, and then get a reaction in two or three days.

I have frequently used Nativelle's digitalin granules, and find them also very efficacious. I have found that one of these granules is equal to 15 minims of the tincture.

Other drugs, such as strophanthus and squills, have the same effect as the digitalis, and in some cases they may cause less digestive disturbance, but in the majority of cases I have found that when the digitalis is ineffective so also are these drugs. In the majority of cases the effects of digitalis are less disagreeable than these other drugs.

In some urgent cases it may be necessary to produce a reaction more speedily, though I have rarely failed to get a reaction in good time by digitalis by the mouth. In order to obtain a speedy reaction, strophanthin may be injected into the veins. In a series of observations which have been carried out at the Mount Vernon Hospital it has been found that in auricular fibrillation with a pulse-rate of over 140 per minute, intravenous injections of strophanthin can reduce the rate and give relief in five or eight hours, but I am of opinion that it is only in very exceptional and urgent cases that this method is required.

It is often stated that digitalis is a dangerous drug and may cause sudden death. I know of two instances where the drug was pushed in cases with a very rapid action of the heart, and sudden death occurred when the heart became very slow. But when we

reflect that cases with heart affections do die suddenly, and that many patients with heart affections do have digitalis given them, it is not surprising that some cases with heart affections who are taking digitalis do die suddenly, but it is not quite logical to attribute the death to digitalis. As I have said, I have had a number of sudden deaths from auricular fibrillation in cases who were not taking digitalis, and I have given digitalis on the lines laid down here to a very large number of patients, and I have never had a sudden death among my own patients; but I must insist upon the effect of the drug being watched, and the drug stopped when the signs of a sufficiency appear. I have frequently seen in consultation patients who were in great distress, because the signs of a sufficiency were not recognized and the drug continued too long.

In these lectures I have endeavoured to draw attention to some of the more striking features of auricular fibrillation. It must not be supposed that I have exhausted the subject, for there are many phenomena which I have not considered, and many more which I have failed to observe. I meet frequently with cases which present new features, and I am at a loss to account for many of the symptoms. A wide field of investigation lies before the clinician, the physiologist, and the pharmacologist, but it is imperative, if ever the subject should be fully revealed, that the general practitioner should take his place as an investigator, for it is he who has the best opportunity of detecting its onset, and of watching the progress of individual cases.

INFUSION ANAESTHESIA :

THE USE OF NORMAL SALINE INFUSION AS A MEANS OF ADMINISTERING ETHER.

BY

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THE progress in the principles and technique of general anaesthesia has been marked in recent years by two considerable and separate advances. The first of these followed upon a long period devoted to the experimental study of the pharmacological properties of chloroform, and was based upon the demonstration of the fact that the inhalation of a vapour containing not more than 2 per cent. of chloroform was for all practical purposes free from danger. The establishment of this fact led to the invention and extensive use of numerous regulating inhalers; of these, perhaps the best known are the German Roth-Dräger, the French Dubois, and the English Vernon Harcourt. No sooner, however, had the advantages of these methods come to be realized than it began to be recognized that there are other dangers contingent upon the administration of chloroform than those which may develop during the actual course of the operation. The possibility that chloroform might be responsible for deaths occurring two or three days after it had been administered slowly won recognition for itself in spite of considerable opposition, and the conditions under which post-anaesthetic acidosis is most apt to develop are now fairly well defined. Although unanimity on this question is far from having been reached, one may venture to express the opinion that at the present day many anaesthetists would hesitate to administer and many surgeons would hesitate to consent to the administration of chloroform in cases of acute or chronic septic processes in the young, in states of inanition or of diabetes.

The increasing importance which is being attached to the possibilities of acidosis has naturally led to greater attention being directed to the use of ether, as that drug is undoubtedly less apt to produce this complication than is chloroform. The methods of administering ether formerly usual in this country very soon failed to justify themselves in the face of critical examination, and it was found that the closed inhaler was by no means so indispensable as had been supposed. The administration of ether by the open method, so long familiar in America, proved to be comparatively easy, and in a high degree satisfactory, in a large proportion of patients, specially the young and

weakly. It is questionable, however, whether the method would ever have come into extensive use in this country had it not been for the discovery that by combining the actions of certain narcotics and of atropine with that of ether an anaesthesia could always be obtained which had almost all the advantages of chloroform anaesthesia and none of its special dangers. The establishment of the value of the scopolamine-morphine-atropine-ether combination was the second great step in the development of general anaesthetics in recent years, and the opinion may be ventured that at the present time there is no anaesthetic of more general applicability. In regard to the comfort of the surgeon and the safety of the patient during the operation, in regard to post-anaesthetic acidosis, and finally in regard to post-anaesthetic gastric and pulmonary complications, this method, when applied to all classes of surgical practice, gives on the whole results which are decidedly better than those of chloroform. It is probable that this opinion would be most likely to meet with opposition in relation to post-anaesthetic lung complications. That it is, however, not altogether unsupported by evidence is shown by the following records from some of the German surgical clinics.

Anaesthesia Produced by Chloroform or Ether.

Surgeon.	Number of Laparotomies.	Percentage of Lung Complications.
Korte	3,909	7.2
Czerny	1,302	3.9
Kümmel	1,754	2.5
Trendelenburg	1,829	5.4

Anaesthesia Produced by Ether Administered by the Open Method.

Surgeon.	Number of Laparotomies.	Percentage of Lung Complications.
Krönlein	1,409	0.56

However much one may be disposed to allow for the effect of the personal factor in the making of these observations, the figures show an advantage on the side of the use of ether by the open method so great as to be unmistakable.

Within the last year it has become obvious that the superiority even of ether given by the open method is not to remain unchallenged. The great volatility of ether, and the necessity, therefore, of using it in enormous amounts when given by the open method, brings into prominence much more clearly than does chloroform the disadvantages inherent in the administration of anaesthetics by the respiratory tract. To this aspect of the matter a little further attention may perhaps be devoted, and an attempt made to enumerate some of the more obvious of the difficulties necessarily contingent upon the use of what may be called the respiratory method. In the first place, it limits one entirely to the use of highly volatile substances, and it would seem probable that if solubility rather than volatility were the only physical character demanded for the administration of an anaesthetic, pharmacological research might be able considerably to enlarge the number of available drugs. Secondly, the respiratory method must always in essence be indirect, the anaesthetic being absorbed from the vapour introduced into the air passages, so that the dose actually entering the blood is rendered variable by the notorious variability with which it enters the chest, being subject to all the accidents of laryngeal spasm, of respiratory spasm, and of variations in the depth and energy of respiration; furthermore, even supposing the vapour to be regularly introduced, it must be supposed that the absorption of it is greatly influenced by variations in the pressures to which it is exposed and by the presence of the large amount of mucus, the secretion of which it tends to excite. Thirdly, the exposure of the very great surface of the respiratory tract to an irritating vapour cannot but be regarded as a serious disadvantage and danger. To any one who has inhaled a breath or two of ether or of chloroform vapour it must always be a source of surprise that serious complications are not invariably produced by