An Address

ON

RECENT ADVANCES IN THE DIAGNOSIS, PROGNOSIS, AND TREATMENT OF HEART DISEASE: THE POLYGRAPH.

GIVEN AT THE OPENING MEETING OF THE SESSION OF THE TORONTO ACADEMY OF MEDICINE.

BY

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MR. PRESIDENT AND GENTLEMEN,—Will you allow me, in the first place, to thank you most warmly for the privilege of addressing you this evening on a subject at which I have been working, in association with Dr. James Mackenzie, for the last few years, and which, in my view, is of the greatest practical importance to the clinician?

Complaint is sometimes made of the slowness of the advance of knowledge which is being made in medicine, and it is sometimes asserted that in recent years, taken as a whole, the advance of medicine has not kept pace with that of surgery. While not fully accepting this view, it must be admitted that there is something to be said in its favour. And, if it be true, it seems to me that the cause lies in the fact that the physician, instead of adopting the methods of exact analysis, is too often satisfied with the most general inquiries and observations in his investigations of the many problems which confront him. In my opinion, what is lacking is an endeavour to bring practical medicine more nearly to the higher state of cultivation which has been reached by experimental science. Perhaps this is more particularly true in regard to the realm of therapeutics. Let me give you a small example of this. It has been believed for generations, both among experimental pharmacologists and practical therapeutists, that the internal administration of aconite directly diminishes the pulse-rate. You will find this belief expressed in the textbooks; but, if you search for real evidence upon which the belief rests, you will be disappointed. A year or two ago I conducted an investigation in regard to this matter. The cases chosen were 3 cases of mitral disease, 1 case of aortic and mitral disease, 1 case of malignant endocarditis with a high temperature, 4 cases of pulmonary tuberculosis, and 7 cases of scarlet fever. All the patients were kept in bed. The pulse was counted nine times a day, at exactly the same times each day, for some days before the administration of the drug, for some days during its administration, and for some days after its administration. First of all, samples of tincture of aconite obtained from several firms of chemists were employed. On being tested at the University College Pharmacological Laboratory each of these samples was found to be quite inert. Afterwards specimens of aconitina prepared in the laboratory were used, commencing with very small and gradually increasing to full doses. On comparing the records of the times when the patients were taking the drug with those when they were not taking it, in no case was there any reduction in the pulse-rate.

Now if it be true that the scientific method of investigation has not been sufficiently adopted in medicine as a whole, it is refreshing to turn to a branch of medicine in which its adoption has been rewarded with results which are nothing short of brilliant, and of tremendous practical importance. The work which has been done in recent years in the domain of heart disease has gone far to solve many of the most fundamental problems which have perplexed clinicians for generations. I venture to put forward the opinion that in few, if any, of the branches of medicine or surgery has there been in recent years a greater advance than has taken place in the realm of knowledge of cardiac disorders. This progress is essentially of such a practical nature and of such great value in regard to the diagnosis, prognosis, and treatment of heart affections, that it is the duty of every practitioner to be acquainted with its nature and scope, and this evening I

want to lay before you some of the main points in the advance, dealing with the subject only from a practical point of view, with the hope that what I have to say will be of use to you in your daily practice.

Let me first of all try and show you how great was the need for new light on this subject. I think I cannot do better than touch upon two problems which have notoriously been sources of difficulty and perplexity to the clinician. The first is the question of cardiac irregularity in patients who may or may not exhibit evidences of valvular disease; the second is the extraordinary difference in the results of the administration of digitalis and its allies in persons who are suffering from identically the same lesions, and complaining of precisely the same symptoms.

Let us take the first question—namely, that of cardiac irregularity. A common experience of the practitioner is this: A patient comes to him complaining of some symptom or other, and in the process of physical examination he finds that there is a very definite irregularity of the pulse. There may or may not be evidences of valvular disease. What significance is he to attach to this irregularity? He is probably aware that cardiac irregularity may signify serious impairment or disease of the heart on the one hand, or, on the other hand, it may be of little or no importance. Indeed, on the one hand, it may be the only sign detected by the ordinary methods of examining the heart in cases in which there is serious involvement of the cardiac mechanism, while, on the other hand, certain irregularities are quite compatible with healthy hearts.

Now the second question—that of digitalis. As long as the drug has been in use for cardiac affections it has been known that the results of its administration are astonishingly various. Suppose you take three patients with precisely the same degree of cardiac failure and exactly identical lesions, and employ the same dosage of digitalis in each case. In one, perhaps, the results are extraordinarily good, the drug seems to act like a charm; in the second the results, though beneficial, are only moderate or slight; while in the third absolutely no good result at all can be detected. What is the cause of this variability? Is the drug capricious in its action or uncertain in its strength? It has been thought so. Or is it due to some particular preparation being active while another preparation is inert? This has been thought by some; and for this reason special preparations have been prepared and advertised as being more uniformly certain in their action. I hope to show you this evening that both opinions are wrong. My object is to try and answer these two questions, to try and clear up these two difficulties. And it is of vital importance to you in your general practice that these two problems should be solved.

Now, the enormous advance within recent years in our knowledge of cardiac disorders has been almost entirely due to the introduction of what are called graphic methods in examining the mechanism of the heart. For by these methods we can analyse the heart's action in a way which was never possible before. By means of an instrument called the clinical polygraph we can take a simultaneous tracing on the same recording surface of the radial artery on the one hand and of the jugular vein on the other. You can readily understand what an advance this is on the older method of merely taking a tracing of the radial artery. For the arterial pulse and apex beat afford information regarding the movements and condition of the left side of the heart alone, and only during the time that the aortic valves are open. The venous pulse, on the other hand, affords information regarding the movements and condition of the right side of the heart. It gives far more valuable information of what is actually going on inside the chambers of the heart than does the arterial pulse. Therefore, by taking simultaneous tracings of both arterial and venous pulses, we can get information regarding the movements and conditions of both sides of the heart, and it is by comparing these that we are able to obtain a precise and an accurate opinion of the cardiac mechanism.

Now, if a tracing of the jugular pulse taken from a normal individual be studied, in each cardiac cycle three main waves are seen. They indicate a rise of pressure in the vein. The first wave in point of time is due to the contraction of the auricle, and is called the "a" wave. The second wave coincides with the

commencement of the contraction of the ventricle, and is synchronous with the carotid beat at the same level of the neck, and is called the "c" wave. The third wave occurs towards the end of ventricular systole, and is called the "v" wave.

Now, under normal circumstances the stimulus for contraction of the heart arises at the remains of the sinus venosus. From this point the stimulus passes through the auricle to the auriculo-ventricular node and along the auriculo-ventricular bundle to the ventricle. The stimulus is conveyed from fibre to fibre by means of a function of the heart muscle which is called "conductivity." We can estimate the degree of conductivity. It can be done in the following way: As I have indicated, the beginning of the wave *a* corresponds with the commencement of auricular contraction. The beginning of the wave *c* practically corresponds with the commencement of the contraction of the ventricle.

You might say that there is an interval of time between the opening of the aortic valves and the carotid pulse. That is true. But the time is so short (it is only about

meet with it in normal individuals, but it is met with in many cases of heart disease. Therefore, if we take all cases of heart disease, whether mitral, aortic, or myocardial, and whether cardiac failure is present or not, we can divide them into two groups—(1) those cases in which the auricular form of venous pulse is present, and (2) those cases in which the ventricular form of venous pulse is present.

And now let us see how these facts are related to the subject in which we are interested this evening; and, keeping to the same order, we will take, first, the question of cardiac irregularity. I have already dwelt upon the confusion in regard to its significance. This confusion was, perfectly natural, because it was found that some cases of irregularity lived to the normal span of life, and did not develop symptoms of cardiac failure; while others died from cardiac failure, perhaps soon or perhaps only after the lapse of some years. The point is, there were no means of determining the significance of the irregularity in any given case, because there were no means of differentiating the types of irregularity, or what any particular variety signified.

Now this is all changed. We are able to classify the vast majority of cases of irregularity into types, and we know what each type signifies, and therefore we have rational and certain grounds for making a diagnosis and prognosis, and, as I shall show you later, in regard to treatment also. So that when a patient comes to us we can with confidence form a tolerably accurate opinion regarding his case.

Now all cases of irregularity, apart from comparatively rare exceptions, fall into one of five groups. I will enumerate them. They are: (1) What is called sinus irregularity, (2) irregularity due to what are called extra-systoles, (3) irregularity due to depressed conductivity, (4) irregularity due to the pulsus alternans, and (5) what may be called complete irregularity.

Sinus irregularity is characterized by a variation in the length of the diastolic period of the different cardiac

Fig. 1.—Normal or auricular form of venous pulse.

one-fiftieth of a second) that it need not be taken into account. Therefore the time distance between the beginning of the wave *a* and the commencement of the wave *c* is a measure of the function of conductivity of the heart. It is called the *a-c* interval. In normally acting hearts this interval is almost constant. It does not measure more than one-fifth of a second. If it does, we know that there is a delay in the conduction of the stimulus, and this means that the function of conductivity is depressed. We call it depressed conductivity. This probably indicates some affection of the auriculo-ventricular bundle.

Let me repeat. A normal venous pulse shows three principal waves and in the following order—*a*, *c*, and *v*, and the *a-c* interval is not more than one-fifth of a second. When in a venous pulse the *a* wave is present the form of pulse is called the *auricular form of venous pulse*. The presence of the *a* wave tells us that the auricle is contracting normally. Under what circumstances do we get the auricular form of venous pulse? It is present in two classes—(1) in all normal individuals, and (2) in a large proportion of cases of heart disease. Please remember that it is present in a considerable percentage of cases of heart disease. When in a venous curve there is no sign of the presence of the wave *a* the type of pulse is called the *ventricular form of venous pulse*, in contradistinction to the auricular form

Fig. 2.—Ventricular form of venous pulse.

of pulse. By the ventricular form of venous pulse we simply mean that there is an absence of an *a* wave. What does the ventricular form of venous pulse indicate? It signifies that the auricle is not contracting in a normal manner. Under what conditions do we get it? We never

Fig. 3.—Sinus irregularity.

cycles, the systolic period remaining constant. The irregularity diminishes or disappears with increase of pulse-rate, while it is apt to increase or return with a slowing of the heart.

There is frequently a definite relationship to respiration; the irregularity is found best during slow respiration, and may only be present on deep breathing. We may be pretty sure that an irregularity is of the sinus type when there is a definite relationship to respiration. On auscultation, the interval between the first and second sound is constant, while the varying difference in the diastolic period can be made out. A certain diagnosis can be made by taking a polygraphic tracing, and usually a tracing of the radial artery is sufficient. In the case of the latter it will be found that there is no irregularity in regard to the size of the pulse waves, but the intervals between the beats vary, although there are comparatively few sizes of intervals.

Sinus irregularity is much more frequent in the young, but it may occur at all ages. It may occur during the administration of digitalis. The act of swallowing may produce it.

If any subjective symptoms are present, they are almost always merely incidental. What is the significance of this type of irregularity? Suppose that in a given case of irregularity of the heart we can be quite sure that the irregularity is of this type, what prognosis may we give?

The answer is, that the irregularity can be entirely disregarded; it is of no practical importance. No treatment is required.

Extra-systoles.—The second form of irregularity is due to what are called extra-systoles or premature contractions. By an extra-systole is meant a premature contraction of the auricle, or of the ventricle, or of both auricle and ventricle together, while the fundamental or sinus rhythm is maintained.

It is of very great importance to be able to recognize the presence of extra-systoles, because they constitute one of the most frequent causes of irregularity of the pulse, and they may be accompanied by subjective phenomena which cause the patient much distress and alarm.

When extra-systoles are present, the normal rhythm of the heart is interrupted either frequently or occasionally, by a premature beat. The pause which follows the premature contraction is abnormally long. This is called the compensatory pause. When this prolonged diastole and the preceding shortened diastole together equal in time two normal cardiac cycles, then the compensatory pause is said to be complete. Since during the prolonged pause the ventricle has had an unusually long

Fig. 4.—Extra-systole marked *. Large amplitude of pulse following extra-systole seen.

period in which to recuperate, the beat of the heart immediately following a compensatory pause often has a greater amplitude than the others. When a premature contraction is interpolated between two normal beats, the form of the extra-systoles is called "interpolated."

On auscultation, in the vast majority of cases two sounds are heard synchronous with each extra-systole. When the premature contraction is so feeble as to fail to open the aortic valves only one sound is heard. Very rarely the extra-systole is so feeble as not to produce any cardiac sounds at all. Auscultatory phenomena are important, because, as I shall show you later, they serve to distinguish extra-systoles from some grades of heart-block.

If an extra systole recurs regularly after each normal beat, so that every normal beat is followed by a single

Fig. 5.—Extra-systole recurring regularly after each normal beat. Simulates pulsus alternans.

extra-systole and compensatory pause, then the pulse beats occur in pairs. The condition is pulsus bigeminus. I may as well mention here that another cause of the

Fig. 6.—Extra-systole so feeble that no wave is palpable at wrist.

pulse beats occurring in pairs is when a patient with auricular fibrillation is getting too large a dose of digitalis. An extra-systole may be so feeble that no wave is felt

at the wrist, so that there is simply a long pause. This gives rise to what is called a "dropped beat" or an "intermittent" pulse. (Fig. 6.) The commonest cause of an intermittent pulse is an extra-systole which fails to reach the wrist. The next most common cause is partial heart-block, to which I shall refer later, and I shall tell you how to distinguish between the two conditions.

Fig. 7.—A tracing of the apex beat and radial pulse. Shows extra-systole occurring after each normal beat which fails to reach the wrist.

If an extra-systole occurs after each normal beat, and the extra-systole fails to reach the wrist on each occasion, there is halving of the rate of the arterial pulse. (Fig. 7.) This also is apt to be mistaken for partial heart-block, but, as I shall show you later, a differential diagnosis can readily be made.

Extra-systoles may be met with at any age, but they are much more frequent in the middle-aged and elderly than in the young. Indeed, in the elderly they are quite common. They are commoner in men than in women. They are more common in people who are the subjects of heart disease than in those who are not, and are more frequent in cases of cardio-sclerosis than in cases of valvular disease. But it should be remembered that there is a large group of cases in whom extra-systoles are present without any other cardiac abnormality. They may be present in people with a history of rheumatic infection, in excessive tobacco smoking, digestive disturbances, supernormal blood pressure, neurasthenia, and as a result of administration of certain poisons, especially digitalis, aconitine, muscarine, physostigmine, and adrenalin. In a considerable proportion of cases they occur without association with any of these conditions.

An individual with extra-systoles may be quite unconscious of their presence. On the other hand, he may experience sensations, and these may cause worry and anxiety, particularly if they occur after the patient has retired to bed. It is for this reason that it is very important that the nature of the complaint should be recognized. The patient may experience a sensation of fluttering in the chest when a premature beat occurs, or he may be conscious of the long pause and complain that "the heart stops," or the contraction of the heart following the pause may be accompanied by the consciousness of a thud or shock to the chest wall in the region of the heart. This thud may be followed by a feeling of exhaustion. The patient may complain of a sensation of gripping in the throat. Rarely, during a prolonged pause, faintness, sweating, and actual syncope may take place, and the anxiety of the patient may be profound. Even Adams-Stokes syndrome may be simulated.

What is the prognosis of extra-systoles? Unfortunately the public have come to attach a serious significance to them. This is absolutely without foundation. When extra-systoles are considered by themselves—that is, without reference to the conditions with which they may be associated—there is no evidence for supposing that extra-systoles can be taken as an indication of an impaired heart or add to the gravity of an already diseased heart. It is of the utmost importance that you should understand this. You may with absolute confidence reassure your patient.

In regard to treatment, your first duty is to remove any alarm in the mind of the patient. Any associated condition, such as dyspepsia or supernormal blood pressure, should be treated. Some hold the opinion that small doses of digitalis are of value for the irregularity itself. I have used the drug in many cases, and have never seen beneficial results to follow. The bromides are sometimes of value in masking or modifying the symptoms, especially in nervous subjects.

The third form of irregularity is that which may occur when the function of conductivity is depressed. I have

Fig. 8.—Occasional dropped beats due to partial heart-block.

Fig. 9.—2:1 heart-block.

shown you that the stimulus passes from auricle to ventricle along the auriculo-ventricular bundle by means of a property called conductivity, and that the stimulus travels at a certain rate. The facility with which impulses pass along this tract may be impaired. There are three grades of impairment: (1) The stimulus from auricle to ventricle is merely delayed—that is, there is merely a prolongation of the interval which separates the commencements of contraction of the auricle and contraction of the ventricle. (2) The stimulus does not at times cross over; in other words, the ventricle does not at times respond to the stimulus from the auricle (this is called “partial heart-block”). And (3) no impulses at all reach the ventricle from the auricle, so that the auricles and ventricles beat quite independently of each other, the ventricles at an approximate rate of 30 per minute (this is called “complete heart-block”).

In regard to the first grade, unfortunately it is only recognized with certainty by means of the polygraph.

In the third grade of heart-block, the auricles and ventricles beat quite independently of each other. As you know, the normal auricular rate is between 70 and 80 per minute. The normal ventricular rate is about 30 per minute; that is why the pulse is slow in complete heart-block. (Fig. 10.)

It is not my intention to go fully into the recognition of the various grades of heart-block. It can readily be understood that this is easily possible by the employment of the polygraph, since this instrument affords separate records of the upper and lower chambers of the heart. It is pretty safe to diagnose complete heart-block when the pulse is 36 or under.

In the severe grades of partial heart-block, and in complete heart-block, owing to the excessive slowing of the ventricular rate causing temporary anaemia of the brain, there may be attacks of faintness, giddiness, or temporary loss of consciousness. Adams-Stokes syndrome may be present.

Fig. 10.—Complete heart-block.

The a-c interval is more than a fifth of a second. There may be considerable variations in the a-c intervals, and this causes irregularity of the pulse. In regard to this grade of depressed conductivity, it is important to remember that as a rule digitalis is contraindicated.

In the second grade of heart-block “dropped beats” occur. These may only be occasional, or they may be more frequent; each third or fourth impulse may fail to reach the ventricle; or every other impulse may fail to reach the ventricle, which gives rise to halving of the ventricular rate, the condition being spoken of as a 2:1 rhythm; or only each third or fourth auricular impulse may be transmitted to the ventricle, and we have 3:1 or 4:1 heart-block. In some cases of heart-block certain ratios may alternate. (Figs. 8 and 9.)

How may we distinguish between dropped beats which are due to extra-systoles failing to reach the wrist and dropped beats which are due to partial heart-block? Of course, we can do so readily by means of the polygraph. But in the great majority of cases there is a much easier way than this. All that it is necessary to do is to auscultate. In the case of extra-systoles which are not palpable at the wrist, heart sounds are heard during the pause, because the ventricle did contract; but in the case of partial heart-block no heart sounds are heard during the pause, because the ventricle failed to contract.

I shall not deal fully with the etiology and prognosis of the various grades of heart-block, as they are dealt with pretty fully in the textbooks. The only point I should like to mention is that heart-block of mild degree, giving rise to “dropped beats,” sometimes occurs during the course of infective diseases, and is then frequently the only sign of myocardial damage. When present it increases the gravity of the primary disease. As a rule, however, it is temporary.

The fourth form of irregularity is that which is due to the presence of pulsus alternans. By pulsus alternans is meant a condition of the pulse in which the rhythm is perfectly regular, but each alternate beat is large and each alternate beat is small. The condition may be continuous, or it may only be observed by something which increases the pulse-rate—as, for example, exercise—or only during a few cycles immediately following an extra-systole. (Figs. 11 and 12.)

It is very unfortunate, but undoubtedly true, that in the vast majority of cases it is necessary to take a tracing of the radial artery in order to recognize it. Very rarely in cases in which it affects the pulse continuously it is perceptible by the finger. As the sign is of very great importance, we should always be on the look-out for it. On very rare occasions the small beats of pulsus alternans entirely disappear, and the pulse-rate is halved.

What is the significance of pulsus alternans? Well, its mere presence, that is apart from whether it is associated with other signs or not, is of very great importance. It is an indication of very great exhaustion of the heart

Fig. 11.—Continuous pulsus alternans.

Fig. 12.—Pulsus alternans following extra-systole at x.

muscle. When the alternans lasts only for a few cycles, the exhaustion may be only temporary. But even in these cases the prognosis must be very guarded. When the condition is continuous, in other words when it persists for many cycles, death usually follows within a few months, or at most in a few years, and sudden death is not uncommon.

In regard to treatment, absolute and prolonged rest, both physical and mental, is urgently needed.

The last form of irregularity to which I want to draw your attention can be described in one word: the irregularity is *complete*. It is an irregularly irregular pulse.

Rarely or never do two beats of the same character or length follow each other. The irregularity is more pronounced when the pulse is fast. With the slower rates we may have to adopt careful measurements of the tracings, as the variations in the length of pause are only small. The pauses between the beats show no relationship to each other, and there is seldom any relation between the strength of a beat and the length of the pause which preceded it—that is, a strong beat may succeed a short pause, and a weak beat may follow a long pause. The pulse is generally more rapid than normal; it may be very rapid. Many beats of the ventricle may not reach the wrist, especially when the ventricle is beating rapidly. Therefore, the ventricular rate should be counted at the

Fig. 13.—Complete irregularity of auricular fibrillation with a fast pulse.

Fig. 14.—Complete irregularity of auricular fibrillation with slow pulse.

apex, either by palpation or auscultation. All the beats may be of small amplitude, but most commonly there is an irregular intermingling of large and small beats.

What may we infer when this type of irregularity is present? We may infer that fibrillation of the auricle is

present. Now, gentlemen, the discovery of auricular fibrillation is one of the greatest discoveries in regard to heart affections which has ever been made. It is of tremendous practical importance that the condition should be recognized in regard to the diagnosis, prognosis, and treatment of cardiac disorders. It is a specific clinical condition, and fortunately its recognition is unattended with much difficulty, and can be made with certainty.

What is meant by auricular fibrillation? By it is meant a condition in which co-ordinate contraction in the auricle is replaced by inco-ordinate contraction. Instead of contracting in an orderly and simultaneous manner during systole, the individual fibres contract rapidly and independently of each other. The result is that systole, either partial or complete, of the chamber as a whole never takes place.

What is the effect of auricular fibrillation on the heart? Instead of the ventricle receiving stimuli from the auricle at regular intervals, it receives them at completely irregular intervals, and thus the ventricle is embarrassed in its work. Also, the impulses which escape are numerous, and if the conducting tissues are able to transmit them, the ventricular rate rises. Thus an irregular, and in the vast majority of cases a far too frequent, pulse is produced; the pulse rate may be as high as 140 or even 180 beats per minute. Very rarely the pulse is very slow. Such a profound change in the action of the ventricle as a rule produces a marked effect on the heart's efficiency.

When auricular fibrillation has once set in, in the majority of cases it persists for the patient's life. But, instead of this, it may appear for a few hours and afterwards never appear, or it may occur at infrequent intervals for weeks or months and then disappear. Many cases of paroxysmal tachycardia are due to auricular fibrillation, and may last for a few seconds, hours, days, weeks, or months. The tendency to occurrence increases, however, until finally the condition becomes permanent. The onset of auricular fibrillation is sudden. As a rule the onset of the symptoms is gradual, but it may be very rapid and cause the patient to become very ill within a few hours. Similarly, if the condition is intermittent, its cessation may be accompanied by an equally rapid and marked improvement in the patient's condition.

What are the symptoms of auricular fibrillation? They are the same as those of cardiac failure from other causes, such as exhaustion, shortness of breath, cyanosis, and dropsy. Patients may also complain of fluttering in the chest and neck or of irregular action of the heart. Apparently, however, they never suffer from angina pectoris. Occasionally there is an absence of symptoms of cardiac failure in auricular fibrillation, and, needless to say, they may be present in heart disease without auricular fibrillation. When the ventricular rate is over 90 per minute as a rule there are symptoms of cardiac failure.

Under what conditions may auricular fibrillation occur? It is found to arise under a variety of conditions. The majority of cases fall within two groups: (1) Those with a history of rheumatism, and (2) patients suffering from cardio-sclerosis. Those with a history of rheumatism frequently have valvular disease, more often mitral than aortic disease, and especially mitral stenosis. The condition has been seen in pneumonia, diphtheria, infective endocarditis, and in people dying of exhausting diseases, such as cancer. Digitalis may induce it in predisposed cases. In other words, auricular fibrillation may be present in any organic disease of the heart (mitral, aortic, and myocardial).

On the other hand, any organic disease may be present without auricular fibrillation. Therefore, we can divide all organic disease of the heart into two great groups: (1) Those cases with auricular fibrillation, and (2) those cases without it.

Are we able to recognize auricular fibrillation? Yes, with certainty and fairly easily, by the following: (1) The pulse is completely irregular. When the pulse is slow, as, for example, when the patient is under the influence of digitalis, it may be necessary to take a tracing of the

Fig. 15.—Multiple undulations in the venous curve with auricular fibrillation.

radial artery. (2) In mitral stenosis, and if a presystolic bruit, due to auricular systole, was present, it disappears with the onset of auricular fibrillation. If a diastolic bruit was present, it persists. A word of warning is necessary here. A murmur filling the whole space between the second and first sounds may be present in cases of rapid heart action, and the latter part of the murmur is not infrequently mistaken for a presystolic murmur due to the systole of the auricle. This mistake need not and should not arise. The murmur is not crescendo in type. On auscultating during one of the long pauses, or when the heart's rate becomes slow, a silence will be detected between the termination of the murmur and the first sound. (3) In a tracing of the jugular vein there is an absence of the normal *a* wave; in other words, there is the ventricular form of venous pulse. The normal *a* wave cannot be present because the auricle does not contract. Instead of the *a* wave, there may be multiple undulations. (Fig. 15.)

In regard to the prognosis of auricular fibrillation, the condition is indicative of some myocardial affection, and, furthermore, it is a specific clinical entity which necessarily has a profound influence on the action of the heart. The prognosis depends upon whether the heart is able to carry on its work under the new rhythm, and this, in turn, depends upon the integrity of the heart muscle. If this be good, for years there may be little or no indication of cardiac failure. In the great majority of cases, however, this is not the case, so that a considerable degree of cardiac failure results. This is especially the case when the pulse is very rapid and there is considerable dilatation of the organ. A persistent pulse-rate of 120 or over is serious. Two points of great importance in trying to form a prognosis of auricular fibrillation are (1) how far is the patient able to modify his life so as to bring it within the limit of the heart's strength, and (2) how does the heart respond to treatment? The latter point will be dealt with more fully later on.

We have now come to the end of what I have to say in regard to the subject of irregularity of the heart. I hope I have shown you that any given case must, apart from rare exceptions, fall into one of five groups, according to its type, and as we know what each type signifies we have certain and rational grounds in regard to diagnosis and prognosis, and, as I shall show you in a few minutes, we have information in regard to treatment also.

And now let us pass on to the problem of digitalis. Why is there such an extraordinary difference in the results of administration of the drug or of its allies in persons who are suffering from identically the same lesion and complaining of precisely the same symptoms? Put briefly, the answer is that the response to digitalis differs according to the condition of the heart and character of the rhythm; those cases of cardiac failure which show wonderfully good results are, in the vast majority of instances, cases of auricular fibrillation. Let me go into the matter in some detail. For the last few years I have been associated with Dr. James Mackenzie and Professor Cushny in conducting at the Mount Vernon Hospital a series of investigations dealing with the action of digitalis, and some of its allies, on the human heart.

Our plan of investigation has been as follows: With the exception of those cases where the symptoms required immediate treatment, all the patients were first given a course of rest before any drug was administered. The rule was not to commence with any drug until the pulse-rate, which had diminished as the result of rest and other causes, had remained stationary for at least some days. This allowed us to study the effect of rest, and it prevented

any drug being credited with results which were in reality due to adventitious circumstances.

Each case was daily observed, examined, analysed, and recorded with scrupulous care, attention being paid to the minutest detail. Graphic records were taken by means of the ink polygraph, and sometimes tracings were taken continuously for long periods, even up to an hour or two.

In regard to dosage, our practice has been to give, as a rule, 1 drachm of the tincture per day; or, if the case was urgent, as much as $1\frac{1}{2}$ drachms, or even 2 drachms a day. These doses were continued until some definite reaction was obtained; usually a reaction was obtained within a week, sometimes in a few days. Rarely was any distinct change to be seen before the fourth day of treatment. The drug was then stopped. If afterwards the heart relapsed to its former condition—which happened in a considerable proportion of cases, and usually in about a week—we endeavoured to find the dose which maintained the improved condition without producing any toxic symptoms. After a thorough trial with digitalis, we often tried strophanthus, squills, or one of the other drugs, and then, perhaps, went back to digitalis. We were thus able to find out the relative usefulness of these drugs, and to estimate the comparative dosage.

The first series of cases examined were 21 cases of mitral disease, 11 cases of aortic and mitral disease (in some of these the only evidence of mitral disease was the presence of a mitral systolic murmur), 1 case with aortic systolic murmur, 3 cases of cardio-sclerosis without evidence of valvular disease, 1 case of paroxysmal tachycardia, 1 case of tachycardia of obscure form, 1 case of complete heart-block, 1 case of emphysema with a mitral systolic bruit, and 3 cases of pulmonary tuberculosis with pyrexia. Of the mitral cases, 10 were cases of auricular fibrillation, while 11 were not. Of the aortic and mitral cases, 3 were cases of auricular fibrillation, and 8 were not. The aortic systolic case was not a case of auricular fibrillation. The 3 cases of cardio-sclerosis were cases of auricular fibrillation. Thus, of the 36 cases of valvular disease or cardio-sclerosis, 16 were cases of auricular fibrillation, and 20 were not. The case of emphysema and the 3 cases of pulmonary tuberculosis were not cases of auricular fibrillation.

Carefully analysing the results of these cases, the following facts were elicited: Of the cases of auricular fibrillation, all excepting 2 showed a marked slowing of the pulse and great improvement in the general condition. The two exceptions were one case in which there was pyrexia present, and another case, a man of 67 years of age, in which, while there were no evidences of valvular disease, there were indications of advanced cardio-sclerosis. The best results were obtained in those cases with a rheumatic history. In regard to the cases without auricular fibrillation, in 2 cases auricular fibrillation developed during the administration of the drug, and these cases responded to digitalis in the same manner as did most of the other cases of auricular fibrillation. Apart from these rare exceptions, in no case was there a marked slowing of the pulse or marked improvement in the general condition; in a few there was a moderate or slight degree of improvement; while in most the administration of digitalis or of its allies appeared to have no beneficial effect at all. Where improvement did take place it was comparatively slow, and it was often difficult to be sure how far the improvement was due to the rest in bed and other measures adopted and how far it could be ascribed to the drug. In general the improvement in these cases was accompanied by no definite decrease in the pulse-rate, but in a few auriculo-ventricular block or very marked slowing of both auricle and ventricle

occurred. The slowing in most cases arose from inhibitory action, but in a few cases it arose from direct action on the muscle.

In regard to dosage: as a rule improvement could be started after a time by small doses of 5 minims of the tincture three times a day, but they always required a much longer period to do so than large doses, which produced their full effects rapidly; and sometimes the small doses produced no effect in cases which responded well to the full doses. The inference is, therefore, that it is better to commence with full doses and to go on with these doses until the patient is completely under the influence of the drug, and then, if required, to continue the administration, but to diminish the dose until it is discovered what dose will keep the patient in the best condition. The indications for stopping the drug were the following: (1) Nausea or vomiting, (2) severe headache, (3) diarrhoea, (4) an unduly slow pulse, (5) coupling of the beats in cases of auricular fibrillation, and (6) partial heart-block in cases without auricular fibrillation. With the cessation of the drug, the stomach symptoms passed away.

In cases of auricular fibrillation there was a majority of cases who relapsed to the former condition in about a week after the drug was stopped. Renewed treatment restored the improvement. After a more prolonged course a relapse was often much less severe, and ultimately the improvement could be maintained with comparatively small quantities or with larger amounts taken at intervals of several days. The maintenance of the improvement was one of the most difficult matters to understand. Only great perseverance in each case enabled us to discover what particular dose kept the patient in the best condition. We found a great difference in the amount required. In one case it was as small as 1 drachm per week, while in another it was as large as 45 minims per day. As I have said, we endeavoured to find the dose which maintained the improved condition without producing any toxic symptoms, and in this respect patients were usually able to say what quantity acted best. Having discovered the best dose to maintain the improvement, patients were discharged, and were usually able to resume work while taking the drug. I should like very briefly to describe to you one case of auricular fibrillation to illustrate the kind of experience we had:

A gardener, aged 24, admitted to the Mount Vernon Hospital February 8th, 1910, complaining of weakness, palpitation, and shortness of breath.

History.—Two attacks of rheumatic fever at 12 years of age, and a subsequent attack at 18. Has been indisposed off and on ever since last attack, suffering from giddiness and shortness of breath. During the last year has been unable to work on account of shortness of breath, palpitation, pain in præcordia, swelling of abdomen, and swelling of legs. Has been in St. George's Hospital during the last four months.

State on Admission.—Orthopnoea. Pulse completely irregular, and the rate varies much from time to time, being at one time 117 and at another 88 per minute. There is a large area of cardiac pulsation in the third, fourth, fifth, and sixth inter-spaces. Transverse diameter of heart $7\frac{1}{2}$ in. At the apex a loud systolic and a soft, short, diastolic bruit audible. The liver is felt pulsating for several inches below the costal margin. Oedema of the legs and hydrothorax are present.

Progress of the Case.—The patient was treated only by rest for ten days, and made a slight improvement, though he at once became worse when he walked a few yards. On February 19th he was put on to 15 minims of tincture of digitalis four times a day. Under the influence of the drug the pulse became slower in a few days, and the patient's condition rapidly improved. After eleven days there was a good deal of nausea, and the drug was stopped. The pulse had come down from 99 to 40. It remained under 50 for six days, when it began to rise and the dyspnoea and palpitation returned. As these phenomena continued, on April 4th digitalis was recommenced. The symptoms steadily improved, and the pulse-rate steadily came down, so that by April 11th, that is after he had taken 10 drachms, the pulse was 44. The drug was then stopped because of vomiting. We then tried him on smaller doses, and after much perseverance we found that his condition was best when he was taking about 100 minims per week. He was discharged on May 29th, feeling well, and has continued at his work, which involves severe physical exertion, ever since.

In cases without auricular fibrillation, in which there had been improvement, the improvement was usually obtained without continuing the drug. This would suggest that rest may have been a more important factor than the drug.

Comparing the different drugs, strophanthus and squills are still supposed to differ somewhat from digitalis in

their effects. We found no essential variation in the action of the three drugs on the heart. It required nearly twice the dose of tinctures of strophanthus and of squills as of tincture of digitalis, but the former two showed considerable variation in regard to dosage. In some cases they seemed to have less tendency to cause headache and gastric disturbances than digitalis, but this was not constant. On the other hand, they appeared to have a greater tendency to produce diarrhoea. In no case in which digitalis failed did any of the other members of that group of drugs succeed. On the whole, digitalis appeared to be more certain in its effects than either strophanthus or squills, but some patients seemed to tolerate the last two more easily than digitalis. Therefore they should be regarded as substitutes for digitalis. As I have already stated, aconite had no effect upon the pulse-rate. In no case in which the tincture of digitalis failed did any of the other preparations of that drug succeed. Samples of tincture of digitalis supplied by firms of chemists of repute proved wonderfully constant in strength.

It was found that the active principles of digitalis, strophanthus, and squills readily underwent decomposition when the tincture was diluted with water, and this was especially so in the case of strophanthus. For this reason the tinctures should be dispensed as such or diluted only with alcoholic preparations, with directions to the patients to take them in water, if necessary.

In a paper which I read at the annual meeting of the British Medical Association at Liverpool, and which was published in the *BRITISH MEDICAL JOURNAL* in September, 1912, I showed from investigations that, judged by the methods in use for observing the blood pressure clinically, the internal administration of digitalis does not raise the blood pressure in man by constricting the peripheral vessels. If that be so, there is no risk in administering the drug in cases of degeneration of the walls of the blood vessels or of supernormal blood pressure.

How does digitalis act in cases of auricular fibrillation? It was supposed that the slowing was inhibitory in origin. This has been found not to be so, for it remains after large doses of atropine. It must arise, therefore, from some direct action on the muscle of the heart. As the auricle continues to fibrillate as before, it may be presumed that the digitalis acts either in the bundle of His or in the ventricle itself. Either fewer impulses reach the ventricle from lessened conductivity in the auriculo-ventricular bundle or the ventricle becomes more refractory; in either case the ventricular rate is reduced.

Now, the practical points which I want you to carry away with you in regard to these and other cases which we have investigated, and from the investigations of other workers, are: Digitalis should not be administered as a mere rule of thumb in all cases of cardiac failure. In any given case, whether there is mitral disease, aortic disease, or disease of the myocardium, you should determine by the means which I have explained to you whether auricular fibrillation is present or not. If fibrillation is present, and it is accompanied by a very rapid pulse, you know that, whatever the lesion, in most cases, and especially in those patients with a history of rheumatism or chorea, you have a therapeutic agency of wonderful potency, and that it is possible to establish and maintain control of the heart-rate. The administration of the drug is followed by a rapid fall in the pulse-rate and a concomitant improvement in the general symptoms. Certainly two exceptions are: (1) Cases of cardio-sclerosis in which the degenerative change is so widespread that little healthy muscle remains; (2) cases in which there is pyrexia. When pyrexia is present, apparently the response to digitalis is as a rule very slight, if at all, whether auricular fibrillation is present or not. It is well to begin with a drachm of the tincture per day, or in urgent cases with even $1\frac{1}{2}$ or 2 drachms per day, and continue until there is nausea or vomiting, diarrhoea, headache, an unduly slow pulse, or what is called "coupling of the beats." Coupling of the beats is a danger signal. We should either stop the drug for a few days or diminish the dose. Usually a reaction is obtained within a week, sometimes in a few days. Then the drug should be stopped until the symptoms have passed away. As a rule the patient relapses. The indication then is to find out what dose suits him best—that is, the dose sufficient to control the heart without producing toxic symptoms. It may require

weeks or even months of careful observation to find this optimum, and much perseverance will generally be required. In this respect help may frequently be obtained from the patient himself, who is often able to say what quantity suits him best; in other words, his own sensations are often a good guide. Having discovered this dose, in the great majority of cases it will be necessary for the patient to continue taking the drug for the remainder of his life. Apparently the cumulative action is not nearly of such serious account as has been supposed. Still the pulse ought to be watched day by day. By this mode of treatment you will save many lives and also bring comparative comfort to people who would otherwise be the subjects of much misery. When auricular fibrillation is not accompanied by a rapid pulse, no marked result follows the administration of digitalis; the result is scarcely greater than in cases without auricular fibrillation. The improvement is slow, and it is often difficult to be certain how far the improvement may be due to the rest in bed and other measures adopted, or to the drug.

If the case is not one of auricular fibrillation you will know that—apart from those exceptional cases in which auricular fibrillation occurs during a course of administration of the drug—as a rule, though, I am glad to say, not in all cases, the beneficial results will be only moderate or slight, or none at all. If improvement does occur, it can usually be maintained without continuing the drug. And, lastly, in regard to the administration of digitalis, it is possible to do harm in cases of diminished conduction.

Apparently, no preparations of the digitalis series of drugs are superior to the tincture of digitalis for ordinary treatment. Strophanthus and squills should be regarded as substitutes for digitalis. They may be tried when a patient is found to be peculiarly intolerant to digitalis.

In regard to the so-called alleged active principles of digitalis, it cannot be too strongly insisted that there is no pharmacological or clinical evidence that they are either pure substances or that different samples of them are uniform in potency. And therefore there is no reason to believe that they are more reliable than, and possibly they are not so reliable as, different samples of the tincture.

In the most acute cases of cardiac failure, when it may be desirable to elicit a more rapid effect than is possible by the administration of tincture of digitalis or one of its allies by the mouth, strophanthin may be administered intravenously, either two or three doses of $\frac{1}{100}$ of a grain at an interval of two hours, or a single dose of $\frac{1}{100}$ of a grain. Marked improvement sometimes follows in from four to eight hours. The action is in every way similar to that obtained by tincture of digitalis by the mouth, except that the same result follows in from four to eight hours instead of in about a week. Whenever necessary, we can continue the administration of tincture of digitalis by the mouth.

I have come to the end of the time at my disposal. My remarks have, on account of time, necessarily been incomplete. But I have tried to solve in some measure the problem of the significance of cardiac irregularity and the problem of the difference in the results following the administration of digitalis.

Many problems still remain to be attacked and solved. But, in conclusion, I venture to reassert the belief that the introduction of graphic methods in the study of heart disorders has been attended with brilliant results, and will compare favourably with any in medicine or surgery which have been introduced in recent years for the benefit of suffering humanity.

MR. P. H. ADAMS, B.M., F.R.C.S., has been elected to the Margaret Ogilvie Readership in Ophthalmology at the University of Oxford.

THE Metropolitan Asylums Board has arranged, for the benefit of candidates for the Diploma in Public Health, a three months' course of lectures and demonstrations in hospital administration—at the Eastern Hospital, Homerton, by Dr. E. W. Goodall, at 2.30 p.m. on Tuesdays and Fridays, beginning April 4th; at the North-Western Hospital, Hampstead, by Dr. J. MacCombie, at 5 p.m. on Mondays and Thursdays, beginning April 7th; and at the Grove Hospital, Tooting, by Dr. J. Beggs, at 5 p.m. on Wednesdays and Fridays, beginning on April 25th. The fee for the course is three guineas.

An Address

ON

CERTAIN PHYSICAL SIGNS OF MYOCARDIAL INVOLVEMENT.

DELIVERED AT THE OPENING OF THE NORTH-EAST
LONDON POST-GRADUATE COLLEGE,

BY

THOMAS LEWIS, M.D., D.Sc., M.R.C.P.,

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LADIES AND GENTLEMEN,—In my address to you to-day I am going to speak chiefly of acute and subacute affections of the heart. This, as you are well aware, is a wide subject, and involves many problems of complexity, and some which will long remain unsolved.

But in one direction the veil of obscurity is rising a little, and it is to the new facts which have been laid bare and their possible significance that I wish to direct your attention at the present time. I have no doubt that it has been repeatedly impressed upon your minds that, in acute and subacute affections of the heart, the damage is not limited to the membranes which cover the organ both within and without. It is needless to remind you that the myocardium also suffers. Yet in practice our attention tends to direct itself especially to that organ or that portion of an organ which is responsible for evident physical signs. Our conception of a given patient's condition is profoundly affected by the appearance of a pericardial friction rub or endocardial murmur. It is but natural, perhaps, under the circumstances, that our thoughts should focus upon pericardium or heart valve, as the case may be. We are impressed by what we hear through the stethoscope, and our diagnosis, "acute pericarditis" or "acute endocarditis," clearly reveals the trend of these thoughts. It is imperative that the myocardium should not be lost sight of; this warning has been repeatedly uttered. The valve and the pericardial sac are relatively but trivial appendages; the simple loss of one or other, though it may increase the burden of work to be borne by the organ as a whole, is not irremediable. Neither valve nor sac is indispensable; efficient or tolerably efficient work can be undertaken and continued for long, if not normal, periods of time by a heart deprived of one of these structures. That fact is taught quite clearly by clinical experience.

The myocardium is the vital part of the heart; its condition should be now, and in the future inevitably will be, the first consideration in all patients in whom the working power of the heart is to be estimated or aided.

The importance of the myocardium, be it in acute or chronic heart affections, is paramount, whenever we regard our patient from the purely cardiac standpoint. And when I speak of the myocardium, I am thinking not only of the contractile tissue of the ventricle, but also of that of the auricles.

These preliminary remarks bring me to my main topic. It is of great importance that any physical sign which speaks of events which are happening in the muscle of the heart should receive the closest scrutiny, and that we should endeavour to ascertain its exact significance. Certain of these signs it is my purpose to discuss.

The greater part of the myocardium may be termed *silent*, in precisely the same sense that certain of the areas of the brain are so termed. Conspicuous lesions of the ventricular wall may be present and give rise to neither sign nor symptom. Large areas of muscle may be degenerate, and the symptoms and signs may be few and obscure. But as there are certain tracts in the central nervous system which, when affected, produce manifest disturbances, so, as recent work has shown us, there are tracts in the heart which display their injuries in a conspicuous manner. The auriculo-ventricular bundle, as you are aware, is a fine neuro-muscular strand which connects to the musculature of the auricle; in its downward course it divides into two main branches, the right and left divisions of the bundle, each of which is connected to the ventricle by an intricate arborization. This system