REFRESHER COURSE FOR GENERAL PRACTITIONERS

THE CARDIOGRAM IN CLINICAL DIAGNOSIS AND PROGNOSIS

II. PRACTICAL APPLICATIONS

BY

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There are two main clinical uses of the cardiogram. The first is in the diagnosis of disorders of rhythm, and the second is in the detection of disease of the myocardium. Rhythm disorders may sometimes be due to myocardial disease.

The Patient with a Cardiac Arrhythmia

In the matter of the arrhythmias the cardiogram gives final and complete diagnosis in almost every case. For the most part the standard bipolar leads suffice, unless special study of auricular activity is called for, when the precordial lead from either edge of the sternum or the unipolar lead from the left foot (VF) will show it well. Oesophageal leads are useful in this respect too.

The common arrhythmias can usually be fairly easily diagnosed at the bedside, with unaided senses, if their nature is properly understood and a careful history is taken. This should not be outside the competence of the general practitioner.

A bradycardia may cause difficulties, but, should the vagus be the cause, there is always exercise or atropine to show it (Fig. 2). A regular tachycardia of, say, 150 may

FIG. 2.—Auricular flutter. Auricular rate 250. As usual, the flutter oscillations appear only in two leads. The ventricular rate is slow, 55, owing to complete heart block, and irregular from extrasystoles (E.S.). Q₁ suggests past anterior myocardial infarction.

cause difficulties. Here, again, the vagus comes in useful owing to the increase in its tone that can be caused by pressure on the carotid sinus, a most valuable clinical procedure. The premature beat should rarely fail to be diagnosed.

Heart block may be undiagnosable in any stage in some cases. The minor grade of incomplete heart block can be detected only by measuring the P-R interval. The dropping of beats can usually be diagnosed by auscultation, but some are very difficult if many beats are dropped and the conduction times are varying. The changeless bradycardia of complete block is usually easily diagnosed, but pronounced bradycardia is not always present, and premature beats may complicate the picture.

Delay of conduction in the ventricles is usually caused by block of either branch of the bundle of His. This may be due merely to local disease or, more usually, may be an indication of widespread trouble. The defect cannot be certainly diagnosed clinically, but there may be suggestive clinical evidence of asynchronous ventricular contraction. Not that this is always due to bundle-branch block, for instead of pathological tardy activation of one ventricle it is possible to have physiological prior activation of one ventricle. But it is safe to conclude that any delay in the spread of the impulse from auricle to ventricle, or within the ventricle, is mostly due to disease.

Auricular fibrillation should rarely be missed, but if the rate is slow there may be difficulty, as the variation in spacing is so slight. If there is any doubt at all a cardiogram should be taken (Fig. 3), for mistaken diagnosis may have serious consequences. There are a number of rare and curious disturbances of function—often harmless yet of academic interest and a joy to the expert, which he would be sorry to miss—that may be stumbled on in this way.

Unfortunately, an arrhythmia may be transient and capricious, and therefore it may not be recorded because the heart's action may be normal at the time of examination. Sometimes very long records are needed for its full elucidation. But the history taken by the expert

may give, or very nearly give, the diagnosis even when no disturbance of function is present.

The study of the arrhythmias depends on the fact that the cardiogram shows the site at which any impulse started, the course which it followed, and the time taken in its spread. These three pieces of evidence provide all the information available for diagnosis. If the source and the course of the impulse are abnormal, the form of wave in the cardiogram will be abnormal. The circus movements of the impulse in the auricle or ventricle are well demonstrated by suitable leads. Here systole (and its P wave) is abolished and the fibrillation or flutter waves are substituted. The prognosis will to a large extent depend on the nature of the arrhythmia. Some types are trivial and

FIG. 3.—Auricular fibrillation. Note fibrillary waves in Lead III, inversion of T in all leads by digitalis, variation in the shape of the T waves.

some are grave in their significance; their importance depends to some extent on their association (the company they keep). By this I mean the question of the presence of any underlying disease in the heart. This may be apparent clinically, or the cardiogram may reveal it when hitherto unsuspected.

The solution of a curve of arrhythmia is usually simple. Occasionally it may be very difficult even to the most expert. Long study of cardiograms makes one realize that the repertoire of the tricks a heart may play is almost inexhaustible.

Myocardial Disease

Lesions of the heart muscle may provoke symptoms of inefficiency by causing undue breathlessness on exertion; the age, habits, weight, and personality of the patient, the physical efficiency of the breathing apparatus, and the possibility of anaemia must be fully considered. Clinical examination may reveal no abnormal physical signs at all, and every lead of the cardiogram may be perfectly normal, and yet the heart may not be healthy. It must be emphasized once again that normal curves do not exclude disease. On the other hand, a supposedly healthy person—for example, an elderly candidate for life assurance—may be shown cardiographically already to have silent lesions which will cause trouble in the future. The strict correlation between pathological curves and pathological states in the heart muscle is often far from close. Disease found at necropsy may not have changed the cardiogram materially, nor may examination of the myocardium reveal the cause of an abnormal curve. The microscope may show but little in a heart that has actually failed.

Probably the closest correlation is to be found in lesions of an ischaemic nature, when they are large enough. Cardiac ischaemia usually causes the clinical symptom of the typical substernal pain, and here, again, careful attention to the patient's story of his symptoms is probably 70% of the diagnosis. Indeed, I must stress that this applies to the full diagnosis in any patient supposedly suffering from heart disease.

To approach the subject more closely, a few general principles may be briefly touched on. In the auricles disease is not of great importance. The two chief disturbances of auricular function—the circus movements of fibrillation and flutter, and auricular paroxysmal tachycardia—have no constantly recognizable pathological changes associated with them. Rarely, the auricular wave may be modified by auricular enlargement (better detected by screening) or by infarction.

It is in the ventricles that the morbid changes are to be sought. Here disease may be widespread or local. Toxic, metabolic, and biochemical causes may underlie the former, and local ischaemic changes due to vascular disease may produce the latter. The morbid process may interfere with the spread of the activating impulse for contraction, which is now regarded as a process of depolarization, or with the process of repolarization that succeeds it, restoring the cells to a condition ready for the next systolic contraction. These defects are reflected in the first part of the ventricular complex (QRS) for the former, and in the T wave or RS-T interval in the latter. But the range of the normal variations for the ventricular complex is very wide. As already stated, the position of the heart in the thorax, depending on various degrees of rotation about possibly three axes, modifies the curve a great deal, and much experience is needed to say that this or that curve is within normal limits.

The best way to proceed with this discussion seems to be to select certain clinical types of case and to show how

the practitioner may be helped by the cardiogram, and also to mention, perhaps chiefly for interest, some conditions in which the abnormal cardiogram provides indication about the degree to which the heart may be involved.

It must be emphasized that the cardiograph is not a penny-in-the-slot machine which produces the diagnosis complete. The cardiogram is only one detail in the clinical picture—its importance can be assessed only by seeing the picture as a whole. The full significance of any curve is appreciated only if the complete clinical background is known. In order to make a diagnosis a thorough knowledge of the individual under investigation is necessary. The art of prognosis depends on the accurate assessment of the significance of as many relevant points in any given case as possible, viewed from experience of as many cases of that sort as possible. A prognosis that hangs on one peg will soon fall. The cardiogram is only one relevant peg, on which too much weight must not be hung.

Diagnosis of Angina Pectoris (Transient Myocardial Ischaemia)

The history is the important thing in making a diagnosis. If there are already pathological changes in the heart muscle the cardiogram may show abnormal features. A normal curve will not exclude the diagnosis. It is known that curves taken during the pain may become abnormal temporarily, so some workers have deliberately tried the effect of provoking pain by exertion to see whether the curve becomes abnormal. Another method is to make the patient breathe air with a low concentration of oxygen (these practices have not become popular in this country); even then the pain may be felt and the curve remain normal. There is also some risk. And quite healthy persons may produce abnormal curves in such conditions.

Diagnosis of Myocardial Infarction

Experimentally, the cutting off of the blood supply to some of the myocardium caused changes in the cardiogram in a few moments. These may disappear if the circulation is restored. Myocardial infarction is an irreversible process. Occlusion of a coronary artery very soon produces a change in the cardiogram. The type of abnormality which results goes through progressive phases. These may be extended over some length of time, from hours to days: as a rule they are quite typical and are easily recognized.

By means of multiple unipolar leads it is often possible, when the infarct is in the front of the left ventricle, to map out its extent. Antero-septal, anterior, and antero-lateral types can be recognized. It may be possible to determine whether the whole thickness of the wall of the ventricle is involved. To be able to gauge the degree and extent of the damaged area in this way is obviously very important. As the changes pass through progressive phases it is possible to say whether the infarct is new or old. Thus it may be determined that infarction has occurred in a patient who has given no clear history that it has happened in the past. Some infarcts develop without pain and may be overlooked in consequence. Some ischaemic changes are gradual and symptomless. The cardiogram, as already indicated, enables the site of the infarct to be located (Fig. 4). Those which form at the back of the heart are less accessible. The unipolar lead from the left foot (and, as a result, standard Leads II and III) usually shows them. Oesophageal leads may be useful in detecting these lesions, but they are not easy to employ.

More than one infarct is sometimes located. To be able to estimate fairly accurately the extent and degree of the

FIG. 4.—Infarction of lateral wall. There is depression of S-T interval in Leads I and II and deep depression of ST junction in V_3 and V_4 . Auricular premature systoles are present in Leads I and II.

infarct may be helpful in prognosis so far as that particular lesion is concerned, but the value is often limited. There may at times be surprisingly good recovery from large lesions.

On the other hand, small lesions may not affect the curve, or not to the extent to enable a precise diagnosis to be made. One may, in fact, find large ischaemic lesions at necropsy in cases in which cardiograms had shown very little abnormality. A negative finding, as in other instances, may not exclude pathological changes, and the clinical side of the diagnosis must predominate.

The taking of serial curves is often very useful in certain types of abnormality. In these a return to normal may be noted. The curves are not typical of infarction, and information about the transient pathological state underlying them is meagre, but there is reason to suppose that in these patients, who have suffered attacks of cardiac pain, the prognosis is much better than in those in whom irreversible disease in the form of infarcts has developed.

But in all these cases of ischaemic disease the prognosis will depend, first, on the after-effect of any one lesion on the cardiac efficiency, and, secondly, on the unknown chances of another attack. In addition, all the other pertinent factors peculiar to each individual case must be considered—his personality, body build, family history, age, and so forth. The value of the cardiogram in prognosis in most of these patients is relatively small. The cardiogram tells nothing about cardiac efficiency or the liability to failure.

Toxic and Metabolic Disorders

After an infectious illness some patients develop cardiac symptoms. These are usually of the type associated with effort syndrome—fatigue, palpitation, tachycardia, breathlessness—and may be regarded as a general lowering of ability to undertake exertion. How far a toxic myocarditis may exist as a pathological entity in such cases is open to question. But there is no doubt that in some instances there may be an abnormal appearance in the T wave of the ventricular complex, or of the RS-T interval. This is a sign of some importance. There is little doubt that in course of time the normal appearance will be resumed, but if such indications of an unhealthy state in the myocardium are discovered, there is definite need for care and restriction of activity on the part of the patient as long as they persist. In these cases a cardiogram may provide useful information.

Under this heading one must also refer to diphtheritic myocarditis, in which cardiographic changes are common and conspicuous. To follow their progress is useful: fortunately a complete recovery is likely.

In acute rheumatic myocarditis the cardiogram may become abnormal, and it is worth taking in a doubtful case. But the clinical evidence of increased heart rate at rest is probably the most sensitive indication of its presence, and a normal cardiogram by no means excludes carditis. Should an abnormal feature be detected repeated curves should be done to check its persistence.

Metabolic Abnormalities.—In metabolic abnormalities such as hypothyroidism (both myxoedema and cretinism) abnormal curves may commonly be met with. What the precise change in the curve is due to is not entirely clear, but it is definite evidence of the involvement of the myocardium and a return to normal should be looked for in controlling treatment. There are many causes for change in the T wave—for example, alterations in the acid-base level and in the potassium level in the blood; such toxic states as uraemia; and deficiency states such as severe anaemia, thiamin deficiency, and possibly also lack of nicotinic acid. These should be borne in mind when curves are being interpreted, and it is useful to remember, too, how in patients suffering from such diseases the myocardium may become diseased. The alterations in the cardiogram due to digitalis are as a rule fairly obvious. However, it is better for a patient not to have had it for 10 to 12 days before the curve is taken; and if it has recently been given the information should always be passed on to the cardiologist.

Pericarditis.—This may cause definite and diagnostic changes in the cardiogram: these are easily recognized, but the clinical diagnosis will in most cases be made on the physical signs. In the constrictive type low-voltage curves are often seen, but the diagnosis depends finally on other clinical findings.

Pulmonary Circulation.—This has troubles of its own. Pathological changes in the pulmonary vessels tend to throw strain on the right ventricle and cause hypertrophy in slow chronic cases and dilatation in acute ones. The effects of pulmonary fibrosis, of whatever type, appear only relatively late; but their detection with the help of the cardiogram assists in grading the severity of the disease. The same applies to emphysema; and also to the rather uncommon disorders which affect the pulmonary vessels, in some of which a raised pressure seems primarily to play a part. Pulmonary infarction may be difficult to diagnose; when the heart is affected by it the result is acute dilatation of the right ventricle. A fairly characteristic cardiogram is seen in about a quarter of all cases, and this may help in the diagnosis when there is doubt. But a normal curve will not exclude pulmonary infarction.

Trauma.—Occasionally a severe blow on the sternum may bruise the heart. This may happen in motor accidents when the driver is thrown against the steering wheel. The cardiogram may give evidence of the damage, and it is important to detect this so that ample time is allowed for recovery. It is well known that patients may suffer from angina of effort after such bruising of the heart.

Congenital Lesions.—As these may cause predominant enlargement of one or other ventricle, the cardiogram may help in making the final accurate diagnosis.

Life Assurance.—In the case of an elderly proposer a cardiogram is useful in helping to exclude early latent disease of the myocardium. As already stated, a normal curve may not exclude it, but, on the other hand, a defect

may be detected which has so far caused no symptoms. In such cases a cardiogram is well worth doing.

Prognosis

As already stated, the prognosis in any individual patient should be based on as many points as possible. The evidence of the state of the myocardium as given by the cardiogram is one of them, but is only a relatively small part of the picture. It is probably correct to say that the larger and more extensive the infarct, the more serious is the outlook. A return to normal in a curve showing ischaemic changes is a good point. At one time it was said that bundle-branch block carried a very bad prognosis, but this is by no means always the case, for the lesion causing it may be quite local. On the other hand, it usually means that there is widespread disease too. If, in following a case with serial curves at intervals, progressive deterioration is found, even when there is not much to be noted on clinical grounds, the prognostic significance is obviously bad.

The psychological effect of the cardiogram is not inconsiderable. The general public has begun to learn something about this method of investigation. To a nervous, apprehensive patient who has become heart-conscious and who may be the subject of a cardiac neurosis the demonstration of a normal curve may mean a good deal in restoring his confidence and peace of mind.

To give an account of the many and various types of curve met with nowadays is quite beyond the scope of this survey. My aim has been to give the ordinary medical man some idea of how far and in what type of case the cardiogram is likely to help in diagnosis and prognosis, with some indication of how that help is obtained. The precise details have not been touched on. These are best left to the cardiologist. The pitfalls are many, and "a little learning is a dangerous thing."

The subject at the moment is changing and complex. The interpretation of the curves is a matter of expert experience. But I believe that out of the present complexity a measure of simplicity will emerge far clearer than any that has hitherto existed.

Figs. 2, 3, and 4 were redrawn by Miss Mary Waldron from East and Bain's *Recent Advances in Cardiology* and are published by kind permission of Messrs. J. & A. Churchill, Ltd.

THE ROLE OF THE MEDICAL LIBRARY

During the annual conference of the Library Association held recently in London a meeting of the Medical Section was arranged at the Wellcome Research Institution on September 20 to discuss "The Role of Libraries in the Advance of Medicine." The chair was taken by Mr. W. R. LE FANU, librarian of the Royal College of Surgeons.

Sir CECIL WAKELEY, P.R.C.S., said that the conference celebrated the centenary of the public library movement in Great Britain. But many medical libraries, of course, were much more than a century old. They varied greatly in type and function. Some were the private working-places of the staff of a particular institute, others were freely open to the whole profession, others again provided a reference service for readers living at a distance. Many attempts had been made to co-ordinate their activities. More than 40 years ago, when he first came to Oxford, Sir William Osler founded a Medical Library Association of Great Britain, but it proved to be short-lived. Twenty years later Sir D'Arcy Power promoted a measure of co-operation among the medical libraries of London. The Royal Society of Medicine had organized, with the Rockefeller Foundation, the Central Medical Bureau, to act as a clearing-house for readers' inquiries, to obtain the

necessary literature from associated libraries and pass it on to all parts of the world in photographic reproduction.

The Medical Section of the Library Association, founded in 1947, acted as a link between medical librarians and provided a forum for the discussion of common problems. Under its auspices training lectures for medical librarians had been arranged, advice had been prepared for the new hospital medical libraries which were being promoted by the regional hospital boards, and a pool for the distribution of duplicate books and periodicals had been organized.

Service to readers rather than conservation of books was the keynote of library work. The opportunity had therefore been taken of inviting a number of leading representatives of various interests within the profession to give their views on the present state of medical libraries and on the most urgent needs for their improvement.

Library Services for the Research Worker

Dr. C. H. KELLAWAY, director-in-chief of the Wellcome Research Institution, said that, in general, medical research was a continuous process—an accumulation of facts until the time was ripe for their co-ordination and for the making of some generalization on which further research could be based. It was rare for scientific discoveries to break entirely new ground, and it was part of the library service to make sure of the connecting links. Few scientific workers could have fully at their command all that had been done in their fields in the past, and the average worker, at all events, needed the aid to his memory which was afforded by an efficient library service. But even when such service was at hand it was the duty of the worker himself to make a critical study of the relevant literature. It was quite common to find papers describing observations and results which, unknown to the writer, had been published perhaps some years before. However, there were some advantages in the repetition of earlier work, and scarcely ever was this done by a worker of ability, with new tools at his disposal, without some new angle of truth being brought to view.

Dr. Kellaway touched on the difficulty of an efficient library service when the units of an organization were scattered over a considerable area. It was easy to provide a good service if all the workers were gathered in one building, but when they were geographically scattered and it became necessary to build up a series of libraries, none of them as efficient as the central one, the difficulty of the task became obvious.

The Role of the Librarian

Dr. HUGH CLEGG, Editor of the *British Medical Journal*, said that medical librarianship was now a highly skilled profession, for which an exacting training was necessary. A library that was solely a storehouse for books and periodicals had only a limited use for those ultimately responsible for the advance of medicine. The storehouse must be converted into something dynamic, and the instrument for this purpose was the trained librarian. He would have preferred the title of the discussion to be "The Role of the Librarian in the Advance of Medicine," because it was on the ability, the character, and the industry of the librarian that the usefulness of a library depended.

The earliest libraries were in temples, and the first librarians probably priests. Later the monasteries became storehouses of learning—collecting, preserving, and cataloguing volumes. The modern library had "stemmed" from the temple and the monastery, and the idea of a jealously guarded collection had persisted into modern times. The 13th edition of the *Encyclopaedia Britannica* (1926) stated that "libraries are now coming to be regarded more and more as workshops." Just when medical libraries began to be converted from storehouses to workshops he did not know. He suspected that the most potent cause of this change had been the need of the research worker for an efficient collaborator in the library, thus compelling advances in library technique and the emergence of a new type of librarian who was something more than a mere cataloguer. One of the functions of the librarian was to teach the research worker how to make the fullest use of the resources of the medical library. The librarian must have a