CARDITIS—ITS NATURE AND CAUSE.

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From both the clinical and the pathological standpoint it is not reasonable to consider infections, inflammations or other conditions which interfere with the heart's action as isolated phenomena. On the clinical side the symptoms produced by lesions of the heart are at least once removed from that organ, while symptoms directly to be ascribed to the heart are common to many conditions where no actual cardiac damage can be proved. On the pathological side the source of the infection, its distribution and its effects, direct and indirect, on other organs of the body are at least of equal importance.

In the following paper it is proposed to glance at the types of disease which produce cardiac symptoms and then to describe in detail the pathological processes which underlie those symptoms. The immediate difficulty is that no organ more than the heart has suffered from loose diagnostic terms, the fatty heart, the tired heart, myocarditis and similar expressions may convey a definite clinical picture but not a pathological one, and it comes as a surprise to find how rare, for instance, myocarditis is as a complication to acute infectious diseases; a myocarditis, that is, which can be detected by the electrocardiograph or demonstrated on histological examination.

The number of ways in which the heart can be embarrassed is very great and as more than one factor is almost always present they are not easy to tabulate; mechanical, nutritional, toxic, allergic and septic are headings which will serve roughly to divide those factors. The septic factors form the subject of a separate paper (page 138).

Mechanical Factors.

Under this heading fall a very large proportion of the cases of so-called "myocarditis." Paul White dismisses the myocarditis of influenza and all the acute exanthemata, except scarlet fever, as an "effort syndrome," while Lewis accepts the term myocarditis for rheumatic fever but suggests myocardial weakness as a more proper description in the majority of cases. This is not to deny that the myocardium is affected by the strain of the various diseases but to restrict a definite term to its own concise meaning. A direct strain is put on the heart, especially the right ventricle, in such diseases as pulmonary tuberculosis and pneumonia, both lobar and bronchial, a strain additional to that of the disease itself. In these conditions no one can question the propriety of diagnosing myocardial weakness but a myocarditis, in the strict sense of the word, is not found.

Nutritional Factors.

Under this heading comes fatty degeneration of the heart; this is always the result of anæmia, either by itself or occurring during the course of a chronic infection or of nephritis. Another type of fatty heart is that found in the obese and though much of the fat is undoubtedly pericardial there is experimental evidence to show that there is also an excess of fat in the muscle, though probably among rather than within the muscle fibres.

The nutritional degeneration which results from a diminished blood supply is dealt with elsewhere (coronary occlusion, page 129).

Toxic Factors.

Toxic conditions of the myocardium are associated with diphtheria, scarlet fever, typhoid, typhus and certain other less common diseases, e.g., yellow fever.

In the case of typhoid and even typhus fever, where it is severe, the importance of the condition is disputed, and though cloudy swelling of the muscle is readily demonstrated at autopsy no delay in the conduction can be demonstrated during life, neither is dilatation of the heart nor are any signs suggestive of a condition more definite than myocardial weakness commonly found. It certainly seems remarkable that in the face of the histology so little clinical evidence of myocardial abnormality should be found.

Diphtheria gives the complete picture of a purely toxic disease of the heart, for one can disregard the very occasional development of localized sepsis. The area of infection is known, circumscribed and remote, the effect on the heart being produced by a known toxin which is capable of isolation and, furthermore, a toxin which produces identical results in an experimental animal. As recently as the last edition of MacKenzie's book the pathology of the diphtheritic heart was not understood; he dismisses it with the statement that it happens but that he cannot account for it. Recent animal experiments, however, show that the mechanism is a perfectly straightforward one. The earliest histological change found in experimental diphtheria is a degeneration of the individual muscle fibre; this is rapidly followed by round-celled infiltration and oedema not only of the parenchyma but also of the interstitial tissues, the ordinary reaction of inflammation and repair.

Animal experiments have made many other points clear. It is found that the degeneration produced by diphtheria toxin is scattered about the heart in small isolated areas, so that even in severe cases much normal muscle remains. It is this, no doubt, which accounts for the excellent remote prognosis, for there is always an ample supply of healthy muscle fibres left to initiate regeneration. The experimental findings also explain the cases of heart block and of sudden death, due to a small area of inflammation having picked out the bundle or one of its branches.

Scarlet Fever. That the hæmolytic streptococcus of scarlet fever produces a soluble toxin is now well established. Like the toxin of *Cornebacterium diphtheriæ* it produces an inflammation of the heart muscle. The effect on the heart is common and occurs as a rule soon after the initial defervescence. The symptoms are directly comparable to those found in diphtheria but are so rarely fatal that their histology is not known; there do not appear to be any germane animal experiments. Later in the course of the disease, about the twentieth day, symptoms, due to a **verrucous valvulitis** may occur. These symptoms are now usually ascribed to a state of allergy, a hypersensitiveness to the bacterial proteins or their decomposition products. They are often accompanied by angina and adenopathy which are also considered to be allergic in nature. The pathological histology of the scarlatinal valvulitis is known and is sufficiently like that of rheumatic carditis to warrant the assumption that they are closely allied in character, a submiliary nodule of the Aschoff type being found. Finally, the organism can enter the blood stream and produce an acute bacterial endocarditis. In this condition a purulent pericarditis may occur.

Allergic Disease.

There is probably no common disease about which medical opinion has undergone a greater change than rheumatic fever. Even in 1910 Osler describes it as an acute arthritis with heart disease as a "complication"; later the heart and the joints came in for equal consideration; now the heart is the dominating feature, the joints being regarded as, one might almost say, a temporary inconvenience. Opinions on the ætiology, too, have varied greatly. In 1913 Poynton and

Paine described the streptococcus rheumaticus, which, coinciding as it did with the work on the green and indifferent streptococci in subacute bacterial endocarditis, gave strong grounds for the belief that rheumatism was an infectious disease. Later work brought disillusion, for not only was the rheumatic streptococcus seldom found but other types of streptococci were at least as often present.

The present tendency is to class rheumatic fever as an allergy, an altered reactivity of the cells to the bacterial proteins of the non-hæmolytic streptococci. The word "allergy" may have become, as Boyd says, one used to "give a touch of mystification to ignorance" but it does represent a known train of circumstances and can to some extent be proved by showing that a hypersensitiveness to this or that substance does exist. In rheumatic fever Swift and his colleagues have demonstrated this and have, moreover, produced a hypersensitiveness to the non-hæmolytic streptococci in experimental animals by first giving them repeated small intracuticular inoculations of those streptococci and then establishing the state by the deep injection of a suitably infected agar inoculum. So far, however, no actual heart lesions have been produced in this way.

The initial lesion in **rheumatic myocarditis** is a fibrous degeneration of the collagen and round this degeneration the Aschoff's nodules develop. These consist of four layers, in the centre the degenerate collagen, then a layer of Aschoff cells (epithelioid multinucleate cells), resembling the giant cells of Hodgkin's disease rather than those of tuberculosis, round these again lie lymphocytes, plasma cells and occasionally polymorphonuclear leucocytes and outside them all a layer of fibroblasts which will later fulfil their normal function by becoming fibrous tissue and the healed scar. The nodule at its largest is just visible to the naked eye; it is situated in relation to the adventitia of a small arteriole by the side of which it lies but which it seldom or never surrounds.

In association with these submiliary nodules there is œdema of the tissues as a whole and it is this exudation which is so susceptible to treatment with the salicylates, drugs which, on the other hand, do not affect the proliferative changes.

A noteworthy feature of the allergic diseases of the heart, as opposed to those previously described, is the *involvement of the valves and of the pericardium*.

In **rheumatic valvular disease** the primary reaction is the formation of a palisade of cells lying at right angles to the surface of the valve and situated along the line of closure; once these cells are injured a local necrosis results which is followed by œdema, the deposition of blood platelets and so the formation of definite verrucæ along the line of contact of the cusps; healing is initiated by a fibroblastic proliferation leading to fibrosis and its concomitant scarring and deformity. Further, the inflamed œdematous cusps are extremely liable to adhere along their line of contact. A similar condition affects the chordæ tendineæ resulting in their becoming adherent, scarred and thickened.

To the naked eye the acute rheumatic vegetation is very different from that of acute or subacute bacterial endocarditis, for it is small, tough and flat and in itself causes little if any obstruction to the flow of the blood; that comes later with healing. On histological examination the verrucæ are seen to consist of platelets and fibrin, no organisms are found.

The **pericarditis** of these allergic diseases is sero-fibrinous and sterile; even during the acute stages soft adhesions between the layers are common and on healing firm fibrous union is the rule. Rheumatic pericarditis accounts for some 28% of all cases.