hare in its production. The combination, however, of milk and fish, seems to have been considered especially unfavourable to the disease. In short, there was scarcely any kind of food that was not condemned by one writer or another, so that if their united directions had been followed, the progress of leprosy would have been effectually forestalled by death from starvation.

Lastly, with regard to the isolation of lepers, I have already hinted that it tended to prevent marriages with those infected, and thus, to a certain extent, checked the spread of the disease; or rather, I should say, that when the epidemic character of leprosy was subsiding, this, among many other secondary causes, assisted in its final extermination.

STRAIN IN ITS RELATION TO THE CIRCULATORY ORGANS.*

By J. MILNER FOTHERGILL, M.D., M.R.C.P.

THE subject of strain in its relation to the circulatory organs is one of high importance, not only from a pathological point of view, but also for its practical bearing on the prevention of disease no less than on its treatment, and, more remotely, on the equitable proportioning of wages in those classes in which diseases of these organs are most commonly found.

So far back as 1856, Virchow pointed out how disease of the aortic valves led to mitral disease, as a consequence of the more forcible closure of the mitral valve under those circumstances. More recently, the inquiry into the subject has been extended; and in 1871 Dr. Clifford Allbutt published his well-known pamphlet *On the Effects of Overwork and Strain on the Heart and Great Blood-vessels*. Since then, the importance of the subject has been more generally recognised, and some review of its present position may be interesting to you all—I can scarcely presume to add instructive.

To commence with the more generally known effects of strain will perhaps be desirable. It has been long recognised and taught that aneurism, dependent upon degenerative changes in the arterial coats, is found most commonly at points where the vessels are most exposed to strain. The fact that in fetal life the right side of the heart is much more largely affected than the left, and that in extrauterine existence this position is reversed, as regards primary disease, has long been well known. No less established is the fact that, when mitral disease has allowed a great portion of the weight of the systemic circulation to fall upon the pulmonic circulation and the right heart, disease manifests itself once more in the latter. Thus we see that, when the right side of the heart is subjected to conditions allied to those of intrauterine existence, the morbid changes of that condition are again induced. For, when the mitral valves are incompetent, the regurgitation of blood on the ventricular systole is opposed by the blood in the pulmonary vessels and right heart, and so the expression that the weight of the systemic circulation is thrown upon them, is not incorrect.

A similar series of changes are inaugurated when a contracted mitral orifice offers an obstruction to the flow of blood into the left heart. These changes are (1) thickening and dilatation of the pulmonic blood-vessels, constituting the condition known as atheromatous; (2) dilatation and hypertrophy of the right ventricle and auricle; (3) disease of the tricuspid valves; (4) changes in the pulmonic valves; this last being less frequent than the others. Similar changes arise from obstruction existing in the lungs without the left heart being affected; but this merely shows more plainly that it is obstruction, with its consequent strain, which is the exciting cause of these changes.

The changes which go on in the muscular walls and in the valves are of a different nature. Increased exertion in muscles leads to their hypertrophy if the conditions of life be favourable. The demand upon them is met by increased growth, giving of course increased power. But in the arterial coats and the valves the changes induced are those of parenchymatous inflammation—a hyperplasia of connective tissue elements. In the muscle, there is hyperplasia of normal muscular fibre giving strength; in the other, there is hyperplasia of primitive cell-elements. Do they give strength too? This question cannot be answered yet. But we do know that this nutritive change leads to distortion and mutilation of the valves; in some cases the free edges are puckered up and contracted, in other cases being agglutinated and welded together. In the first series insufficiency, permitting regurgitation, ensues; in the latter stenosis, producing obstruction, results.

As changes in the right heart follow valvular disease in the left heart, so changes in the mitral valves very commonly follow affections of the

aortic orifice. Virchow has taught that valvular endocarditis is more common in the left than in the right heart, in consequence of the greater muscular force of the left ventricle; so we find that, when aortic disease has led to hypertrophy of the left ventricle, changes in the mitral valves become frequent—less in aortic stenosis, where the hypertrophy is not so great; more in aortic regurgitation, where hypertrophy attains its highest development. The increased force with which the mitral valves are closed induces those nutritive changes entitled chronic endocarditis. It must not be overlooked that in aortic regurgitation the mitral valves are closed by the aortic as well as by the ventricular systole; and, as Traube points out, this is not without its effects on the valves and their attachments.

More interesting still, and even of greater importance in the prevention of disease, are the changes in the aortic valves themselves, and the causation of those changes. Placed at the base of the aortic column, they are closed by the aortic systole on the arterial recoil. Every increase in arterial tension will close the semilunar valves with greater force. Aortic valvulitis is met with under two totally different circumstances—(1), in the gouty individual with chronic renal disease; (2), in the young and robust who pursue certain forms of labour.

At first sight, there seems little in common betwixt the action of gout-poison and the labour of the hammerman. Still the morbid processes induced by these two totally different causes are, apparently, not only identical, but even the manner of their immediate causation is the same. In both cases the aortic valves are exposed to violent closure from increased arterial recoil, and in both cases valvulitis from strain equally results.

We will take the striker's or hammerman's case first. Here we find that for certain periods of time, recurring at brief intervals, the muscular power is being displayed; not the arms merely, by which the blows are delivered, but also almost all the other muscles are in action, so as to secure such an attitude that the blows may be delivered with the greatest effect. There exists, indeed, a condition of general muscular contraction, a condition most unfavourable to circulation through the muscles. Not only so, but, as Wardrop observes in his work *On Diseases of the Heart*, a book all too soon lost sight of, the muscles in many cases cross or compress the arterial branches, and thus obstruct the forward progress of the blood. This matter forms the second chapter of Wardrop's book, and is entitled by him "The Musculo-Cardiac Function." The first effect of this obstructed circulation is muscular hypertrophy of the heart, which enables the ventricles to contract with greater force, and so to empty themselves of their contents, and to deliver them into the arteries with greater force to meet the increased obstruction. The blood is forced into the elastic arteries under greater pressure while the flow forward is impeded. This leads to increased arterial distension and augmented recoil, and thus the aortic valves are closed under greater pressure. Under these circumstances, we find aortic valvulitis very common. Possibly in some cases, the amount of fluids imbibed, by increasing the vascular fulness, adds to the already mentioned causes of valvulitis.

We now come to aortic valvulitis in connection with chronic renal inefficiency, known by the various designations, chronic of Bright's disease, granular kidney, etc. Without entering into the question of a recent discussion with which all are familiar, we can review the changes in the organs of the circulation in chronic Bright's disease here so far as they bear on the subject of strain. In a large number of cases, if not in all cases of chronic renal disease, there exists hypertrophy of the muscular tunics of the arterioles. It is enough for our present purpose that we have two separate authorities for this statement, each of whom is a competent observer capable of defending his position, viz., Dr. Traube of Berlin, and Dr. George Johnson. These two eminent authorities hold that, in a large number at least of cases of chronic renal disease, there is hypertrophy of the muscular tunics of the arterioles, a condition which does not permit the blood to escape so readily from the arterial system, the result being increased arterial tension, and consequent hypertrophy of the left ventricle. Here, then, we have the blood forced into the arteries under increased pressure, while the flow forward is obstructed by hypertrophied arterioles; the elastic tubes which connect these two muscular ends of the circulation are unduly distended, the arterial recoil is increased in force, and aortic valvulitis follows from this augmented force and violent closure.

Thus we see that the circumstances under which aortic valvulitis is most commonly found are really identical, though at first sight so dissimilar. The importance of the recognition of this fact is very great. In the first place, we can see how remedial measures may affect those changes inaugurated by renal inadequacy. In the second place, we may be enabled to aid the working man, in whom these changes are being established, to avoid further damage by changing his form of labour for some other less trying occupation. For if this form of

* Read before the Metropolitan Counties Branch.

labour cannot be abolished, and thus the changes engendered thereby be obviated, some good at least can be achieved by substituting some other form of labour, some other method of obtaining a livelihood, for this which has induced disease in healthy organs, and can, if continued, but aggravate the morbid processes which it has inaugurated. That under favourable circumstances these morbid processes may be retarded, is almost if not quite certain. In the case of voluntary efforts, which can be abandoned when becoming distinctly harmful, this can be really seen; in other cases where the struggle for existence necessitates a continuance of the labour, the unfortunate consequences of continued strain upon the circulatory organs are painfully apparent.

A general recognition of these facts would lead to some more equitable and fair remuneration of the men exposed to disease from mechanical strain. The rate of wages should be such that the man can, if so inclined, make provision for himself when this form of labour must be abandoned, and some easier occupation substituted in its stead, and also for his family when he is taken away, as he almost certainly will be, before he reaches what we term the allotted span of existence.

In addition to the changes in the heart and its valves, let us see what are the effects upon the blood-vessels themselves of this continued strain. While we have seen that aortic valvulitis is induced by increased arterial recoil from augmented distension, it is impossible to overlook the effect of this distension upon the walls of the arteries themselves. Under these very circumstances just mentioned, we find that atheroma is induced in the arterial coats, the same parenchymatous inflammation, in fact, which in the valves constitutes valvulitis. It has long been known that atheroma is most frequent at points of greatest strain or tension, the arch of the aorta, especially the outside of the curve, at points of junction of vessels, at points of flexion, etc.

It is also well known that the pulmonary artery and its branches become atheromatous when subjected to increased strain in mitral disease. It is also well known that the walls of a vein become atheromatous when an artery opens into it. The lining membrane of the auricle becomes firm, thickened, and rigid, behind a diseased mitral valve, when the auricular wall is subjected to great and increased distension. Under these circumstances the auricular wall is sufficiently rigid not to collapse when cut into, and its internal appearance is not unlike that of a dilated and atheromatous aorta. Arteries are also liable to atheroma in proportion as they are exposed suddenly and immediately to great distension, as in the cases of the renal and coronary arteries, both short vessels coming off at once from the great arterial trunk.

General atheroma is common in aortic regurgitation where the vessels are suddenly and extensively distended by a large mass of blood being thrown at each stroke into the arterial system; and, that too, under the augmented pressure of a highly hypertrophied ventricle, for in aortic regurgitation the ventricular cavity is enlarged as well as the walls hypertrophied. So, too, in the hammerman and in the gouty person the elastic tubes which connect the two muscular ends of the circulation are liable to become atheromatous, from the increased distension to which they are subjected. We have, then, atheromatous vessels and aortic valvulitis found together, a combination, as we know clinically, common enough.

This view of the causal association betwixt atheroma and strain is not original, and is commonly held and taught in Germany, while in this country it has been enunciated by Dr. Clifford Allbutt, as well as by that accomplished pathologist, Dr. Moxon. (On the Nature of Atheroma in the Arteries. *Guy's Hospital Reports*.) That certain constitutional conditions may favour the development of atheroma is probable; but there is every reason to agree with Dr. Moxon's conclusions, viz.—“1. That what is called atheroma of arteries is sub-inflammation of various degrees, of which the lower degrees end in fatty degeneration of the coats, along with the inflammatory products; and 2. That the determining cause of the occurrence of this change is mechanical strain.”

If, then, mechanical strain leads to atheroma and its terrible consequences, aneurism and apoplexy, if it leads to valvulitis, and to such changes as seriously affect the muscular walls in consequence, and, more remotely, to all the fearful consequences of muscular failure, no apology is necessary for bringing the subject of mechanical strain in relation to the circulatory organs before your notice.

We are all clinically well aware of the association betwixt valvular disease and atheroma, and dyscrasial conditions, as gout, syphilis, and habitual drunkenness. But though we have been conscious of the fact, little light has ever been thrown upon the relationship, and it is extremely doubtful if these conditions in themselves do more than render the subjects of them more liable to changes which are less readily induced in healthy persons. It would appear that these conditions, tending as they do to induce prematurely those tissue-changes now known as senile

degeneration, favour valvulitis from its usual provoking cause, and not from any special action belonging to themselves. In gout we have seen that the exciting cause, strain, is aggravated; and in habitual drunkenness renal disease is so common as to leave no room for surprise that aortic valvulitis is also frequent, without any favouring conditions due to the dyscrasia.

The occurrence of atheroma and aortic valvulitis in syphilis is not so apparent, though the connection betwixt syphilis and the vocal chords—parts also exposed to tension—is not without importance, and throws some light, at least, on the present subject.

The effect of mechanical strain is also interesting, in regard to the forms of heart-disease in the two sexes. Not possessing any statistics, it is necessary to fall back on general impressions—distinct general impressions, however. From my experience, the conclusion has been forced upon me, that the greater portion of heart-disease, actual organic heart-disease, in women, is rather a yielding of the heart-walls, a form of weak heart, than valvular disease, especially disease of the aortic valves. Where the latter occurs, it is usually in elderly women, with chronic renal disease, and then we cannot expect sex to afford much protection. In man there is a decided tendency to aortic disease, with its accompanying changes.

It is difficult to divest oneself of a strong suspicion that this is not so much due to mere sex, but rather to the pursuits of each sex. The occupations of man render him more liable to strain on the circulatory organs, and its consequences, valvulitis and atheroma. Probably these changes in the subjects of syphilis are much more common in the male than the female, due to their different pursuits. Females are, however, subject to aortic valvulitis, when exposed to mechanical strain. In Vienna, where much of the coarser work is done by women, Bamberger, in fifty cases of aortic regurgitation, found no fewer than twelve cases in women. This also throws some light on the effects of mechanical strain.

What determines valvulitis in the mitral valve, commonly the subject of such change, we cannot yet say. We know that the mitral valve is very liable to be affected in acute rheumatism, and, according to the Germans, in scarlatina, though to a less extent; but as yet these are ultimate facts of which no satisfactory explanation has been forthcoming. Virchow's view, that the frequency of mitral valvulitis is due to violent closure of this valve by the muscular left ventricle, seems highly probable.

Finally, we may sum up the foregoing in several propositions.

1. Changes in the right heart are induced by increased strain when the mitral valve is diseased.
2. Mitral valvulitis often results from aortic disease, in consequence of the mitral valve being forcibly closed by an hypertrophied ventricle.
3. Aortic valvulitis, as well as atheroma, is intimately associated with mechanical strain.
4. Certain dyscrasial conditions, in which these affections are common, merely favour the occurrence of such changes.
5. Women are much less subject to aortic valvulitis than men are, and this is due to their pursuits rather than to their sex.
6. The importance of mechanical strain in the production of disease in the circulatory organs is scarcely yet sufficiently appreciated.

In conclusion, no attempt is being made here to give mechanical strain any undue prominence in the causation of disease in the organs of the circulation, but merely to point out such indications of its importance as the present state of our knowledge will warrant. Nor can it be supposed that it is possible, in a brief summary like this, to bring forward evidence to substantiate each conclusion. The conclusions are only what appear to me to be indicated by my investigations and reflections. Such as they are, they are given to the profession in the hope that they may attract such an amount of attention as may substantiate them, or explain them away. Whichever happens, we may hope that the truth will be ultimately elicited. Should they be substantiated, a direct impetus will be given to the treatment, both preventive and palliative, of a large class of most important diseases.

DESCRIPTION OF A NEW DOUBLE CURRENT INHALER FOR ADMINISTERING ETHER.

By J. T. CLOVER, F.R.C.S. Eng.

THE opinions of medical men on the merits of ether and chloroform are so various, that I think I need not apologise for attempting to reconcile them. There are some surgeons who do not hesitate to express their opinion that chloroform is an uncertain agent; that it is dangerous in some cases, and in others not; and that we cannot always discover beforehand whether it will prove so. To such men, ether, which very