SUMMARY.

1. Eclampsia and pre-eclamptic toxæmia are due to the products of the early degeneration of a piece of placenta whose blood supply has been interfered with.

2. Infarction of the placenta may be due to mechanical detachment of the organ from the uterine wall—for example, in placenta prævia and in some cases of accidental hæmorrhage. In other cases it is due to thrombosis; this is the factor operating in most cases of eclampsia.

3. Where time is allowed for the elaboration of toxic elements from the detached placenta toxæmia develops. In concealed accidental hæmorrhage, therefore, toxæmia is conspicuous. Absorption of placental poisons only occurs if and whilst part of the placenta remains attached to the uterine wall.

4. Toxæmia occasionally accompanies placenta prævia for the same reasons.

5. The toxæmia develops after the hæmorrhage; it is therefore not the cause of the bleeding in accidental hæmorrhage.

6. The major symptoms of eclampsia are probably due to the flooding of the mother's system with the breaking-down products of liver cells (and perhaps of other tissues), which were killed some hours or days previously by the placental poison. Compare the interval that elapses before the development of symptoms in phosphorus poisoning, etc. A consideration of this sort accounts for the occasional occurrence of *post-partum* seizures.

7. Recent investigations on shock (Quénu, Delbet, etc.) support by analogy this conception of eclampsia. These observers have shown that the early disintegration products of muscle are toxic. The injection of these substances into an animal may kill at once. On the other hand, the lethal effect may be delayed for some time, in which case it is due to degeneration of the liver and suprarenal glands. The changes induced in the liver in such a toxæmia resemble those found in the liver in eclampsia.

This investigation was carried out at the instance of the Medical Research Council. It was conducted at the Royal College of Physicians' Laboratory, Edinburgh.

CARDIAC PERISTALSIS AND MITRAL STENOSIS.

BY

D. W. SAMWAYS, M.A., M.D., D.Sc., M.R.C.P.,
MENTONE, FRANCE.

IN an article entitled "Dilatation of the Heart," published in the *BRITISH MEDICAL JOURNAL* of February 5th, 1921, I showed that the pressure which the cardiac walls can, theoretically, exert on their contents varies inversely as the cube of the diameter of the enclosed chamber. Thus, when a chamber has by contracting reduced its diameter by one-half, its walls could, because of their physical advantages, exert eight times as great a pressure on the enclosed residual contents, and when the diameter has fallen to one-third they could exert twenty-seven times the pressure that was possible at first, the force of contraction being the same throughout.

Not that I imagine that the cardiac walls can fully effect this, as they are not perfect spheres, and they have deficient muscular areas at their valve orifices. They must, however, be physically capable of more or less following the physical laws which govern contracting hollow spheres, and of exerting enormously greater pressures on their residual than their full contents, or, expressed otherwise, of expelling their residual contents with much less effort than their first expelled contents.

The principle to which I am calling attention can be readily appreciated by the purchase of a big rubber air-balloon with thick walls, as sold to children, and of a similar small rubber balloon with thin walls. If these are mounted on a three-way glass tube and air blown in by the free orifice, only the big balloon will dilate; the small thin balloon will resist the air pressure which dilates the large thick one. If, now, the inflated big balloon be clamped off and the small one separately inflated, and both afterwards connected together, the

small thin balloon will blow its contents into the large thick-walled one and inflate it further.

I maintain that there are conditions in the working of the heart in which the thin-walled auricle can similarly force its contents into the thick-walled ventricle when the ventricle is contracting against it, and that the appreciation of this fact is essential to understanding much that is observable in cardiology.

It is universally admitted that the auricle begins its contraction before the ventricle. The auricle, therefore, is becoming a small chamber while the ventricle is becoming a large one, through receiving the auricular contents. Towards the end of its contraction the auricle has but a few units of area of blood to contract on, while the ventricle, being full at that time, has many. The auricle also by contraction has thickened, while the full ventricle is at its thinnest. Should the contractions overlap, and the ventricle begin its contraction before the auricle has finished, the supposition of so many writers that the ventricle must in that case overcome the auricle is not evident. In the Bramah press it is not the big piston which overcomes the little one, but the reverse; and the full ventricle is at a greater relative disadvantage than the big Bramah piston, having a minimum of contracting efficiency at the moment when the area of resistance is at its maximum.

Now it is commonly supposed that the contraction of the auricle is over before that of the ventricle begins. This view does not accord with that of many of the most noted earlier observers who specially investigated the subject. Thus Dr. Barclay wrote: "The fibres forming the auricle being intimately associated with those which surround the ventricle, the two cavities do not contract and dilate alternately, but the contraction of the one overlaps to some extent that of the other." He added, however: "When the mitral valve is much altered, the more powerful contraction of the ventricle must overcome that of the auricle if there exists anything like an opposition between them."

Professor Potain, the greatest French authority during the last half-century, maintained that, normally, the closure of the auricular-ventricular valves corresponded in time with the opening of the aortic valves, and that the contraction of the auricle lasted till that closure. Had he been able to conceive that the auricle could oppose the ventricle, if their contractions overlapped, he would not have been forced to place, as he was, the beginning of the ventricular contraction at the moment, or just before, the aortic valves opened.

Professor Potain heard the murmur of mitral stenosis (so-called "pre-systolic") during the apex beat, and, believing it to be due to the auricle, maintained that the ventricular contraction must begin later. Dr. Dickinson heard it also during the apex beat, and maintained that it must therefore be ventricular-systolic in origin. The trouble with these observers was that they could not imagine that the auricle could drive its blood on in spite of the ventricle if their contractions overlapped, whereas I have shown that the chance of the auricle being physically able to do this is greater than the chance of the ventricle being physically able to oppose it, especially when the auricle is hypertrophied.

In the classic investigations made by Professors Roy and Adami² graphic tracings are given showing the relation in time of the chief cardiac events. Roy and Adami actually placed tambours in the cardiac chambers so that the various pressure changes could be exactly recorded. The auricular contraction, as given by them, was at its maximum when the apex beat was at its maximum, and had not finished, in normal cases, when the aortic valves opened, thus showing a marked overlapping of the auricular and ventricular contractions.

Moreover, in harmony with this, Roy and Adami found that the papillary muscles did not contract to support the auricular-ventricular valves till the moment when the aortic valves opened. This strongly suggests that some other force was supporting these valves during the first part of the ventricular contraction. That force, fairly obviously, must have been the contracting auricle itself, which I maintain was physically competent to do it.

An overlapping of the systoles is probable *a priori*, for primitive cardiac contraction is peristaltic, and the essence of a peristaltic contraction is that each segment in sequence takes up the contraction and maintains it during the

expulsive period of its successor. In this way the great veins near the auricle contract and close first, and maintain their contraction during the expulsive period of the systole of the auricle. It would require an infinite force to open a fully-contracted vein, so that regurgitation from the auricle is amply prevented. A sphincter is as good as a valve to protect the veins. In birds the mitral valve itself is only a sphincter.

When the auricle contracts, it likewise appears to maintain its contraction, prolonging it into ventricular-systolic time, thus for a period supporting the auricular-ventricular valves. The ventricle also appears to maintain its contraction, as Roy and Adami's curves show, for an appreciable period after the outflow of blood into the aorta, thus for a time supporting the aortic valves.

In the case of mitral stenosis any overlapping of the contraction of the auricle on to that of the ventricle is obviously likely to be increased. It is difficult for the auricle, even if hypertrophied, fully to expel its contents through the stenosed mitral orifice before the advent of the ventricular contraction; and just as the contraction of a ventricle is normally longer than that of an auricle, because of the greater opposition its contraction experiences, so the resistance opposed to the auricle, when the mitral orifice is stenosed, is likely to prolong its contraction, and make it more ventricular in character.

Keyt of Cincinnati, as quoted by Professor Marey³ maintained that "one of the characteristics of aortic stenosis was the long duration of the ventricular systole." Dr. Hilton Fagge wrote: "If the mitral orifice be stenosed, the contraction of the auricle will be slower than normal, and the beat of the ventricle will thus be delayed." Dr. Galabin and Dr. Mahomed made very similar statements, after examining their graphic curves taken in cases of mitral stenosis. Dr. Sansom⁴ wrote: "It is obvious not only that the auricle (in mitral stenosis) contracts in a manner much more powerful and much more prolonged than under normal conditions, but also that it contributes in very marked degree to the general elevation (apex beat) which is completed by the systole of the ventricle." French writers, such as Dr. Constantin Paul, have advanced much the same opinions.

Observers such as these could not follow to a useful conclusion the evidence of their senses, because they believed that the power of the auricle did not count as compared with that of the ventricle, and that any overlapping of their contractions could have no physical utility.

As a matter of fact there is no obvious reason why, if the auricle has contracted to, say, half its diameter, in a case of mitral stenosis, before the contraction of the ventricle opposes it, the auricle should not continue to send on its residual contents into the full ventricle, the aortic valves opening, or the ventricle expanding to receive them. This is rendered the more possible by the fact that the walls of the ventricle, in well marked mitral stenosis, are thinner than normal, while those of the auricle are hypertrophied. I have seen an auricle with walls hypertrophied almost to the thickness of the ventricle. Dr. B. Foster and Dr. Sansom have reported auricles with walls measuring up to 6 mm. in thickness, exceeding, that is, the thickness of the right ventricle.

The ventricle can never exert its potential power of opposing the inflow of the residual blood from the auricle, because directly its contraction has raised the intra-ventricular blood pressure above that in the aorta its contents escape into the latter, and no further raising of blood pressure on its part is possible. The maximum resistance the auricle could, therefore, ever find opposed to it by the ventricle is determined by the pressure in the aorta, and an auricle towards the end of its contraction, especially if hypertrophied, could, theoretically, being small, exert a sufficient pressure on its residual contents to overcome this. Allen Burns described a case under his observation in which the ventricles became calcified, and the man lived for a long period with the auricles alone doing the whole work of the circulation.

It may be objected that in cases of mitral stenosis the auricle dilates as well as hypertrophies. I believe this to be one of the fictions of medicine. In a paper published in 1898⁵ I gave particulars of an analysis I made of all the *post-mortem* reports of Guy's Hospital during the ten years 1886-95. Out of a total of 4,791 necropsies during that period, there occurred 196 cases of stenosis of the mitral orifice. Of these cases, 23 came from the surgical wards,

and only one among them appeared to have died of asystole due to the stenosis, which was severe. If this case be excluded dilatation of the left auricle was only observed in 3 of the remaining 22 cases, where death occurred from accident or operation before the heart broke down. Dilatation, therefore, is not a feature of the disease during its course. I doubt if 3 in 22 be materially greater than the average for the heart generally at necropsies. The paper referred to established the fact, so far as statistics could establish it, that the characteristic change in the left auricle in mitral stenosis is hypertrophy, and that dilatation is a break-down phenomenon occurring late in the disease.

CONCLUSIONS.

1. There is considerable evidence to show that the contraction of the auricle normally overlaps that of the ventricle, lasting probably till the moment of opening of the aortic valves.
2. That in cases of mitral stenosis this overlapping tends to be still further prolonged, invading therefore the expulsive portion of the ventricular systole.
3. That the ventricle could not prevent the auricle sending its residual blood into it, if their contractions overlapped, because at that time the auricle, being small, would have few units of area of blood to contract on, and a thickened mass of muscle to exert the necessary pressure, whereas the ventricle would be in exactly the reverse position at the time.
4. In cases where the mitral was stenosed the auricle would be further helped by hypertrophy of its walls and thinning of those of the ventricle.
5. That the murmur of mitral stenosis ("presystolic") goes up to and into ventricular-systolic time because the blood flow does likewise.
6. That the murmur is "crescendo" in character because the auricle can exert an ever-increasing pressure on its contents as it contracts. Theoretically the pressure can increase inversely as the cube of the decrease in diameter.
7. That regurgitation through an incompetent mitral orifice is prevented, probably for years, by the contraction of the auricle behind that orifice during the expulsive portion of the ventricular systole.
8. That the presystolic murmur is replaced by a systolic murmur when the auricle cannot decrease its size in time to become a sufficiently small chamber to defeat the oncome of the intraventricular resistance, but on the contrary is defeated by it. This will allow regurgitation, the auricle will speedily dilate, fibrillate, and compensation will break down.
9. Temporary recovery by rest or bleeding will probably mean that the auricle becomes again, for a short time, master of the situation.

REFERENCES.

- ¹ *Lancet*, March 16th, 1872. ² *Practitioner*, vol. 44. ³ *Circulation du sang*, p. 687. ⁴ *Albutt's System of Medicine*. ⁵ *BRITISH MEDICAL JOURNAL*, February 5th, 1898.

BILHARZIA DISEASE IN EGYPT.

BY

J. B. CHRISTOPHERSON, C.B.E., M.D.,
F.R.C.P., F.R.C.S.,

TROPICAL DISEASES CLINIC, MINISTRY OF PENSIONS; LATE DIRECTOR
OF THE CIVIL HOSPITALS OF KHARTOUM AND OMDURMAN.

THE outstanding facts in Drs. Lasbrey and Coleman's article on 1,000 cases of bilharzia treated by antimony tartrate, in the issue of the *BRITISH MEDICAL JOURNAL* of February 26th, are, as it seems to me—

1. The prevalence of the disease in and around Cairo.
2. The applicability of the treatment of bilharzia—both complicated and uncomplicated cases—by intravenous injections of antimony on a large scale in Egypt; and, most striking of all,
3. That the prestige of the British doctors with the fellahen of Egypt, at the present period of national unrest, is proof against the prejudice aroused by religious and political mischief makers.

The cases were all voluntary, and, since the completion of this series of 1,000 cases in August, 1920, another 1,000 have been done in five months. The C.M.S. Hospital, Old