Original Communications.

NOTES AND OBSERVATIONS ON DISEASES OF THE HEART AND LUNGS.

By T. Shapter, M.D., F.R.C.P., Senior Physician to the Devon and Exeter Hospital, etc.

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It is now proposed to see how far that law of hydraulics which, while enunciating that the momentum of a liquid is as great as that of a solid, further states that anything which receives the momentum will receive as severe a blow as if from a solid, is applicable to the normal valvular sounds emitted by the heart, and is borne out by the rhythmical phenomena observed during the heart's action. In considering the effect of these phenomena, we soon find that the estimation of other conditions and elements is necessary, viz.: the capacity for resonance of the various tissues which are directly influenced by this momentum, and how far the parts immediately surrounding them are media favourable for the conduction of sound. Nevertheless, they neither add to, nor detract from, the above law.

To proceed. Immediately succeeding the second sound, there is the "pause", occupying two-fifths of the period in which the cycle of the heart's action is performed. The "pause" is characterised, with the exception of the presystolic sound, which is probably due to the eddying of the blood as it passes through the auriculo-ventricular openings, by no ostensibly external active phenomena. It is the period in which the ventricles, by the agency of their elasticity, are gradually expanding, and therefore drawing or sucking in the blood from the right auricle and vena cava, or from the left auricle and pulmonary veins, as the case may be. This is done, looking to the supply afforded by the auricles, so gradually, that the auricles are scarcely collapsed thereby, the blood apparently flowing into these latter almost, if not quite, as quickly as it is thus drawn from them. In all this there arises no obstruction to the flow of blood, nor any indication of the formation of eddies, save, as above stated, such as may be indicated by the presystolic sound; the blood passes easily and inaudibly from the auricles into the ventricles.

This period of the "pause" is then succeeded by the first sound. This takes place at the precise moment in which the ventricles start into contraction, and when the mitral and tricuspid valves are thrown back and closed by the blood thus forcibly impinging against them, and when, as a necessary consequence, these valves recoil on the onward current of blood proceeding through the auricles. One of the functions of the auricle, and perhaps the chief, is now exemplified; for, so sudden and so violent is this closure of the valve, that the obstructed current immediately distends the auricle, and, were it not for its elasticity on the one hand, rupture might ensue, and for those fleshy columns, the *musculi pectinati*, on the other, a constantly recurring over-distension.

The following observations made by Dr. Carpenter (*Principles of Physiology*, p. 557) are so confirmatory of the above, that I venture here to quote them, especially as the facts mentioned therein were recorded entirely independently of the views now sought to be deduced from them. He is referring to the case of a child which came under the notice of Cruveilhier, and where, from the accidental exposure of the heart, ample opportunity was afforded for carefully observing the phenomena, and that by a practised and most competent observer. "The diastole of the heart has the rapidity and energy of an active movement: triumphing over pressure exercised upon the organ, so that the hand closed upon it is opened with violence. This is an observation of great importance; but of the cause to which this active dilatation is due, no definite account can be given. But the dilatation of the auricles appears to be much greater than can be accounted for by any *vis a tergo* (which, as will hereafter appear, is extremely small in the venous system) or by the elasticity of its substance, for it was observed in this case to be so great that the right auricle seemed ready to burst, so great was its distension, and so thin were its walls. Moreover, the large veins near the heart contract simultaneously with the auricular systole, and not with its diastole, so they can have no influence in causing its dilatation."

The first sound, then, is synchronous with this distension of the auricle, and with the simultaneous closure of the auriculo-ventricular valves, and occupies, equally with the preceding "pause" two-fifths of the time consumed in the cycle of the heart's action. Assuming it to be due to the forcible closure of these valves against the stream of blood flowing from the auricle into the ventricle, this dull and prolonged sound may be accounted for partly by the energy of the valvular contraction, and partly by the comparatively large column of blood thus acted on; but chiefly by this column itself impinging on a large amount of soft membranous material, the sound being thus distributed and rendered less sharp, as it also probably is by the expanding of the auricle itself, by which the momentum of the fluid is modified.

It is probable that all these causes, more or less, combine to make that difference in the duration and quality of the first sound, from that which is observable in the second sound, by which it is immediately succeeded.

This second sound, which is comparatively loud and sharp in tone, occupies a duration of time amounting to only one half of that proper to the first sound, and takes place at that moment of time in which the ventricles, after having by their rapid and forcible contraction closed the auriculo-ventricular valves, and after having impelled the blood contained within them into the arteries, resume their quality of elasticity, and then again commence their suction-power. They now offer the condition of being able to redraw back to themselves the blood they have just discharged; but no sooner is such a backward stream commenced, than the semilunar valves are forced thereby into action, and here there occurs, as was the case on the closure of the auriculo-ventricular valves, a sudden obstruction to a moving current of fluid. But this obstruction, though prompt and energetic in its action, and effected through the medium of membranes easily acted on by the opposing current, and being from their structure better conductors of sound, has not to contend with so large an amount of fluid as is the case with the auriculo-ventricular valves, when their respective contractions take place, nor does the fleshy and contracted and consequently empty ventricle offer so fit a medium for the distribution of sound, as is the thin and distended auricle. Hence this second sound is short, sharp, and loud, while the first is dull and prolonged.

The cause of these two sounds is, primarily, the interrupted momentum of the moving fluid; their quality and duration being due to the density

of the medium of the obstruction that receives the blow of this interrupted momentum, together with that of the parts surrounding, they being the means whereby the sound is conducted and rendered appreciable.

Such, then, is the explanation now offered of the normal rhythmical sounds of the heart; but experience shows that these may be variously interfered with, and to the pathologist there then arises an anxious field of inquiry. It now becomes necessary to ascertain whence proceeds this interference, and to what morbid changes or disordered actions it may be due.

Of the disturbance in rhythm only, nothing need here be said, as it will be the subject of reference presently; but we will pass on to a brief consideration of the special physical causes of the substitution, by murmur, of the normal sounds.

In pursuing this inquiry, it will be found that the hydraulic law of the production of sound by the eddying of currents still satisfactorily explains the phenomena of these murmurs, and that a due appreciation of the bearing of this law will assist greatly towards forming just and satisfactory conclusions in the instances presented to us. In the course of discussing some of these, to be subsequently more particularly referred to, this will be rendered more obvious. For the present it will, by way of illustration, be only necessary to summarise some of the more salient positions induced by disordered action.

If the mitral or the tricuspid valves, though efficient as regards their valvular office, present any obstruction to the flow of blood, there will arise a murmur, and this will precede and perhaps entirely take the place of the first sound. In the former of these two instances, the murmur is concluded by it. More often, however, the murmur entirely masks the normal sound; but in both the murmur is induced by some valvular obstruction or want of proportion between the current of blood and the aperture through which it passes, so that a sonorous eddy is thereby caused. But if there be imperfection in these valves, whereby, on contraction of the ventricles, a regurgitation of blood takes place into the auricles (and it is well to bear in mind that this is not an unfrequent condition of these valves, both in disordered states of the heart, as well as in its diseased states), the first sound is never heard, but only a murmur, and that a protracted one, and sometimes even so protracted as to greatly interfere with the audibility of the second sound, or at any rate with its easy and correct appreciation.

The explanation of the above is, that the imperfection in the valves, as regards their closing function, does not efficiently offer an obstruction to the momentum of the flowing current, and hence there is wanting the normal first sound, whilst the murmur, in place thereof, may probably be due to a sonorous eddy in the blood as it enters the ventricle, but certainly to the eddy induced by the regurgitation into the auricle through the limited aperture in the unclosed valve, during the contraction of the ventricle. When the murmur is so protracted as to interfere with the second sound, there is generally abnormal patency, permitting a sonorous regurgitant eddy, and this may succeed and be continuous with a sonorous eddy caused by obstruction to the stream of blood when flowing into the ventricle. The sounds induced by these two eddies are so continuous as to be undistinguishable by the ear, as having two separate and independent sources for their production.

Under these circumstances, the above phenomena will certainly occur, unless it be in those rarer cases where, with a dilated and enfeebled ventricle, the valves are so patent as to offer little or no obstruction to the regurgitant blood; then perchance no proper murmur may occur, but only a continuous and tumultuous sound. The explanation of this is to be found partly in the very undue patency of the valves, and partly in the enfeebled and disordered condition of the ventricle, inducing a deficient momentum in the current of the blood itself.

If there be an obstructing imperfection in either of the semilunar valves, uncomplicated with other morbid complication, there will be a murmur, most probably so distinct and pronounced as somewhat to interfere with the audibility of the first sound—this is, as it were, absorbed and overpowered by it. The second sound immediately succeeds this murmur. Both the murmur and the second sound are heard most distinctly at the base of the heart, over the region of the aortic valves, and in the course of the aorta. This series of phenomena is explained by the sonorous eddying of the blood produced by the imperfection of the valve being synchronous at its commencement with the first sound. For the most part, obstruction is the cause of the murmurs in the semilunar valves. More rarely they are produced by imperfections permitting regurgitation; and then, when regurgitation with an attendant murmur does exist, it is almost always preceded by murmurs as the evidence of obstruction.

It is necessary to observe great caution in concluding the presence of a regurgitant murmur in the semilunar valves. It is probable that it is less common than is generally assumed to be the case; and, most certainly, a murmur often appealed to as evidence of an imperfection in these valves permitting regurgitation, has been eventually shown not to be due to this cause; but, possibly, to only very slight obstructive causes to the systolic flow, or, may be, to some dilatations in the aorta, or even in the pulmonary artery. In investigating and diagnosing the source of these murmurs, it must not be lost sight of that, as they are due not exclusively to regurgitation, but to perturbations in the flow of the blood, they may equally be produced by aneurisms in these arteries, and where there is no regurgitation, as by that amount of imperfection in the valves which permits it.

To what indications are we, then, to appeal for a correct diagnosis as to the precise seat and origin of a murmur thus situated, so as to decide whether it be, firstly, caused by imperfection in the semilunar valves, or, secondly, whether it be regurgitant or otherwise? Certainly, not to the quality of the sound itself; but, amongst other circumstances, to its position as regards time and place; and the due estimation of this is, more frequently than otherwise, most difficult; for, if these valves present so imperfect a condition as to permit regurgitant murmurs, they likewise are deficient in that perfect condition of structure necessary to offer a complete and successful opposition, or contraction, to the momentum of the obstructed stream of blood.

On looking exclusively to these valves, we might perhaps say that, where a murmur is synchronous with the heart's systole, it is due to obstruction, and to obstruction only; but that, where it is synchronous with the diastole, then it is due to regurgitation. In this latter case it should be somewhat prolonged, as continuing during the more lengthened period of the diastole—it being then, and then only, when regurgitation should ensue; and, inasmuch as the diastole is more gradual than the systole, and the arteries, whether aortic or pulmonary, are not favourable vessels for supplying, in a retrograde mode, blood to the ventricles, the regurgitant sounds would be comparatively feeble, and for the most part continuous with

the systolic murmur, or so in succession to it as to present what may be termed a double murmur. Regurgitant murmurs in the semilunar valves are, however, comparatively but of rare occurrence.

The two normal sounds of the heart, as has been shewn, are due to the closure of the valves against the current of the blood. The murmurs, on the other hand, are, as regards the valves, heard under disordered conditions of these valves, so that their normal relations to the flow of the blood become disturbed; and hence they may arise whenever there is a current of blood relatively too large for the aperture guarded by these valves, and thus presenting a condition of obstruction to its free flow. Any circumstances, therefore, occurring to these valves whereby the fluid passing through them finds a narrowed passage will produce a murmur, and consequently it is immaterial, as a source of sound, whether the blood flows normally onwards or abnormally backwards—the physical condition as regards production of sound is the same.

It may be, in the present day, no very difficult task to set forth what may be the sounds heard as proper to each lesion of the heart; nevertheless, practically, a differential diagnosis is frequently fraught with great difficulty, inasmuch as the sounds and murmurs are often continuous, or one sound may mask or entirely supersede another. Then, again, there is the contiguity of the similar parts of the two hearts, and the synchronism in their actions and their sounds, to be estimated and carefully and duly separated.

The due appreciation of these confusing indications requires much practical skill, and a large necessity for taking into consideration many attendant circumstances. Some few of these constantly recurring difficulties in diagnosis will now be referred to.

[*To be continued.*]

CHLOROFORM IN DYING.

By Joseph Bullar, M.D., Physician the Royal South Hants Infirmary.

So many cases where most attention is expected, are those where disease can only be palliated, that palliation becomes a very important part of our duties. Few of this large class are more distressing, than when extreme restlessness and sleeplessness accompany the exhaustion of the last days or weeks of the life of the very aged, especially when (as is often the case) the mental consciousness is still active, and the failure of power in the vital organs is actually felt, with none of that physical courage to bear the suffering, which the same patients had when younger and stronger. That true health, or at least that tenacity of life on which its long duration depended, keeps them alive and suffering, and conscious of this suffering, for a length of time tedious to themselves and often most wearisome to those who watch over them, and who look (so often in vain) to medical aid for an alleviation which would relieve themselves as well as the patient.

Small opiates, which at an earlier stage may have been useful, at this later one often aggravate the distress instead of soothing it; and it is in this condition that the cautious inhalation of chloroform is a great boon.

A lady, aged 82, had been for some years confined to her bed and sofa, and, without any appreciable bodily disease, was now gradually sinking. For some years she had suffered mentally from depression taking a religious form as to her soul's safety, and so persistently, that it seemed like a delusion from the powers of the brain becoming enfeebled. But she had a good appetite; could employ herself much with finger-work; and, though confined to her room and much in bed, had a very fair amount of bodily health. Some months before her death, the delusions were attended with more excitement and irritability; she slept less, and often not at all; and her appetite gradually declined. Small doses of liquor opii sedativus (from five to ten drops) at night soothed her at first; but, as her strength diminished, the same doses excited her brain, and she lay in a very distressing state of restlessness and prostration, exacting constant attention from those watching her. She lost her appetite and power for solid food, and could only take small quantities of beef-tea and weak brandy and water. In this painful condition, about five weeks before her death, I recommended the inhalation of twenty drops of chloroform at a time at bedtime, on a handkerchief; having first given it to her myself, to see whether it soothed and was agreeable to her, or otherwise; and it was found that this prevented the exciting affects of the liquor opii sedativus until its narcotism exhibited itself, and by both together she had quieter nights. But, after a few days, the opiate was discontinued, as it excited, and chloroform alone used, with so pleasant a result to the patient herself, that she frequently, by a sign, indicated her wish to inhale it, and was partially for a month and wholly for five days before death kept almost constantly under its moderate influence. The effect was to quiet the delusions, to make her mind peaceful and happy, and also to raise the pulse and respiration. Her daughter observed this, and I found it to be the case. When she was so weak that the pulse could only be felt with difficulty, a short inhalation of chloroform rendered it distinctly perceptible, and the respiration became slower and more natural.

At my request, one of this patient's daughters stated in writing their observations on chloroform in their mother's case, as the inhalation was carried out by these ladies and a middle-aged sensible attendant.

"A pleasing feature in her case," writes the daughter, "was, that chloroform never made her really insensible; it only lulled her pain, gently calmed her spirits, and frequently, but not always, sent her to sleep for a few minutes, when she would awake quite herself, with a perfectly natural look and manner, and perhaps ask how long she had been asleep; and this after so many months of fearful excitement. We felt nervously anxious at first of giving her too much, and we never omitted to watch the pulse. One morning, after breakfast—a time when she was generally low—I had given her the usual dose of brandy and water, when she said, 'I do not like the brandy as I did; give me some of the nice stuff to smell' (meaning chloroform). I did so with some anxiety, as she was so low, when, to my great relief, the pulse gradually rose. I continued giving small doses at short intervals, when it very soon regained its usual strength. After this, we constantly noticed the same thing; and we no longer hesitated to give her as much as she craved, especially as the breathing powers were much relieved and became more free, and the countenance took a peaceful and happy expression, such as we had rarely seen in her of late years. To our minds, this craving was an instinct of nature. She had for a long time been asking for something to smell, and nothing we could get for her seemed what she wanted; but, when she had once felt the effects of the chloroform, she never asked for anything else, but for that constantly.

"My mother used just under a quart. The greater part was given during the last week or ten days of