animal was exposed by removal of a portion of the chest wall, respiration and anaesthesia being maintained through the tracheal cannula. In such the heart would be observed to be suddenly arrested on completing the electrical circuit, to undergo distension when the current ceased to pass, and then to enter into a state of fibrillary tremor maintained for a variable period, while the animal would make deep respiratory efforts as evidenced by forcible movements of the diaphragm. It has not seemed to us necessary in this paper to go into details regarding the voltage and ampère of currents used, nor to insist upon a measured relation between the current employed and the weight of the animal, experiments through lower to higher voltages having demonstrated to us that there was no absolute relation—we of course speak within limits—between the voltage employed and death of the animal. By this we mean that whilst naturally a discharge of high voltage would kill an animal and that immediately compared with a lower we did not find that a smaller animal was necessarily killed by a lower voltage than an animal twice its size. Frequently it was just the reverse of this. Circumstances rather suggested to us that the younger and the less highly organised the animal the higher the potential of the discharge required to kill it, compared with that needed for an older animal and one occupying a higher plane. To this circumstance and others still under investigation we hope to allude in a subsequent communication.

Into the appearances presented by the various organs *post mortem* we need hardly enter, beyond stating that after death from electric shock the left ventricle of the heart may contain a very small quantity of blood, while the right ventricle, auricle, and the large veins near the heart are distended and filled with dark fluid blood. Granted that the fatal result in alternating current discharge is brought about by heart and not by respiratory failure, it will be at once seen that the problem of treatment of resuscitation in apparent death from electric shock is much increased in difficulty. We have made preliminary experiments with many cardiac tonics and have endeavoured to excite contraction of the arrested heart in various ways—by stimulation, by relief of the overloaded cavities—but hitherto with indifferent success. Thus far artificial respiration appears to hold out the only possibility of restoration, but if recovery is not accomplished in 20 or 30 minutes the prognosis would seem to be very unfavourable. We have succeeded in resuscitating two animals apparently dead from electric shock by means of artificial respiration, once after an interval of 20 minutes. As has been shown by other observers, the administration of amyl nitrite before the shock diminishes its effects, but the practical value of this observation is not apparent.

The experiments just narrated deal only with alternating currents, which are generally thought to be the most dangerous to life. We propose to extend the investigation to the effects of direct or continuous current discharges, with the view of inquiring how far the opinion of electricians in this direction is justified. This, with a fuller consideration of some of the points only briefly raised in this preliminary communication, we hope to make the subject of a future paper.

THE USE OF POSTURE IN PERCUSSION OF THE HEART.

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WITH the introduction of new methods of treating the heart, the importance of mapping out the boundaries of the organ has acquired fresh interest. Questions arise daily which emphasise anew the desirability of attaining greater precision in the art of percussion; but it cannot be said that the advance in our knowledge has brought us any nearer this much-wished-for goal. On the contrary, there is ample evidence, in the many papers dealing with the subject, of the unsatisfactory position of the question, and it is quite clear that so long as certain anatomical and physiological factors are frequently lost sight of, there will be little advance towards a clearer conception of the condition of the heart. Our methods of percussion are doubtless simple enough in themselves, and

produce precise results in the cadaver where the relations the internal organs are fixed; but in the living body, they are admittedly difficult to interpret, and perhaps it is too much to hope, in the present state of opinion, for the adoption of a common plan which will afford some basis of comparison. My attention was more particularly directed to this question three years ago, while engaged with Professor Haycraft in investigating the movements of the heart within the chest cavity. (The results of this investigation were brought before the annual meeting of the British Medical Association in London in 1895).¹ We observed very striking effects on the position of the heart when the posture of the body was changed, and this gave rise to the suggestion that it might be of value in clinical observations. Since that time I have adopted a method of percussion which, I have learned from experience, possesses certain advantages, and adds materially to the accuracy of the examination. This posture percussion, as it may be called, was investigated by Salzer and Drescher some years ago, and later by Gumprecht,² in a paper recently published; and my experience closely coincides with theirs.

It is well known that in changes of posture of the body the heart follows the laws of gravitation, and the influence of posture on percussion and the heart's impulse has been investigated by von Dusch, Gerhardt, and others. Their observations were, however, limited in scope, and did not deal with the changes in the prone position. The diagrams published by the former show the effect produced by change of posture from one side to the other to be considerable. But no attempt was made to ascertain the area of dulness with the body in the face position, and the result obtained was not of great practical value. The alterations in the percussion area with the body on the left side, were of service in showing that the heart was not fixed; but it gave a misleading estimate of the boundaries of the organ, and the suggestion to make clinical use of it has not been realised. In Walshe's work on the heart, it is stated that "in the prone position, and in decubency on the left side, the heart comes more fully towards the chest wall than in the supine posture or in decubency on the right side." There is no suggestion that this fact may be used as an aid in percussion, and it merely describes the mobility of the organ. The alteration in the site of the cardiac impulse by posture, which has long been familiar to clinicians, illustrates very well the range of movement possessed by the organ. Dr. Arthur Ransome³ investigated many years ago the position of the impulse in different postures of the body—recumbency, erect attitude, right and left side. He ascertained the side-to-side movement in fifty-one individuals to have a mean extent of about $3\frac{1}{2}$ inches—a maximum of $5\frac{1}{2}$ inches and a minimum of 2 inches. More recently Guleke⁴ has dealt with this point in an exhaustive manner, and his conclusions, taken from the examinations of some hundreds of patients, go to show that out of every five males between the ages of 41 and 50, in one only is the impulse palpable in right-sided recumbency; in two in the supine position; in three in the erect attitude, and in four with the individual on the left side. So that in this last position, in one only out of the five will the impulse remain unfelt. These figures serve to demonstrate the influence of gravitation in causing movement of the heart. They do not deal with the prone position—which has been overlooked, although it modifies the impulse as well as the percussion area—but they indicate clearly that there may be considerable movement of the organ within the chest cavity.

It is not generally recognised that the operation of the law of gravitation modifies to some extent our conception of the relation of the heart to the other viscera and the walls of the chest. Our knowledge has been obtained from an examination of the opened chest cavity, where disturbing factors are introduced. Within the chest the heart is attached at its base to the great blood vessels, being slung, so to speak, in the bag of the pericardium, and closely clasped by the lungs. It possesses no absolute fixed point, even the base partaking of a considerable degree of movement. The greater part of the organ is entirely free within the pericardial sac, and may undergo marked alteration in position when subjected to certain influences. It has been pointed out by Haycraft and myself⁵ how important the action of gravity becomes in the open chest, and how it has influenced the description of the movements of the heart since

the time of Harvey. If an animal with an opened chest be held face downwards in the prone position, the heart falls forwards in diastole, and springs back during systole. When the animal is placed upon the back and the chest opened, the heart sinks towards the back and the left side, and springs forward at each contraction. This action operates likewise in the unopened chest, but, as we shall see later, its range is more restricted when the walls are intact. In the human cadaver we have the same influence. However great the care taken to preserve the normal relations by fixing the parts by means of needles, I have found generally that as soon as the chest is opened some shrinking of the lung borders takes place, and the heart by its weight falls backwards and presents a more flattened anterior surface than it has during life. Normally, the lungs are in close contact with the heart, as a whole; they accommodate very readily to any change in its shape and position, and we have the borders displaying an ever-varying relation to the walls of the heart. They respond readily to all changes in the heart, and fulfil the functions of a delicate oncometer whose movements may be graphically registered by the cardiopneumatic tracing. It is this intimate connection which is not so apparent in the opened chest, for there the heart may have fallen away and the lungs have retracted even to a slight extent, which suffices to destroy the accurate representation of parts in life. It is doubtful whether the lungs actively influence the position of the heart, except perhaps in forced respiration, as Kronecker appeared to assume, when he speaks of the "massage of the heart." Gerhardt, indeed, doubts the active displacement of the heart by the lungs, and a study of the cardiac movements in the opened chest will show the readiness with which the pulmonary borders adapt themselves to the diastole and systole, and follow closely any deviation of the organ when the posture is altered. If an animal be placed on the left side, the heart falls to that side and compresses the left lung, whilst the right lung moves across the middle line and preserves its intimate relation to the cardiac wall. Again, if a glass plate be applied to the front of the opening in the chest and the animal held belly downwards, the heart tilts forwards, flattens out its anterior surface on the glass support, and pushes aside the pulmonary margins. This adaptation of the lungs is very intimate, and in view of the great variation of which the right side of the heart is capable within physiological limits, it seems to me that the existence of three lobes in the right lung is of service, as it enables that organ to accommodate itself more closely to the changes taking place in the ventricle.

If we turn now to the unopened chest, we have evidence also that the heart is influenced by the force of gravity. This was derived by a method which was adopted by Haycraft and myself in our investigations. Dogs were placed in various positions (prone, supine, left side, and right side) and killed. Precautions were taken to avoid external pressure likely to disturb the chest wall, and the bodies frozen. Sections were then cut by a saw, and photographs taken at once, and afterwards both section and photograph compared. This enabled an examination of the thoracic wall to be made *in situ* before any disturbing influence could be introduced, and we got a representation of parts as they are in life. On comparing photographs taken from corresponding parts of the heart in dogs placed on the back, face, and left side, the effect of gravity is apparent at a glance. In the first position the heart is closely embraced by the lungs, and to a considerable extent, anteriorly, only a small portion of the anterior surface coming into contact with the chest wall. Fig. 1 is a tracing from a photograph of a section of a dog in the prone position, and shows the heart closely applied to the chest wall over a large area, its anterior surface notably flattened whilst the lungs are thrust backwards, and do not come into extended relation with the chest wall in the cardiac region. The organ has, in fact, by its weight, spread itself out, so to speak, on the thoracic wall, presenting thereby a greater surface, and preventing that overlapping of the lungs which is seen in the back position. In Fig. 2, from an animal on the left side, there is a considerable change to be noted. The organ has moved to the left side, and though it touches the wall there is no extension of the area of apposition and the surface uncovered by lung is not larger. The right lung extends as far forward as the middle line, closely enveloping

the right side of the heart. If we calculate roughly the area of apposition to the chest wall, we find in Fig. 1 nearly one-third of the circumference of the whole heart uncovered by lung; in Fig. 2, not more than one-sixth. In the paper already referred to, we have inserted two tracings (marked Figs. 3 and 4) from a prone and a left side position, taken from sections nearer

Fig. 1.—Tracing of a photograph of a frozen section (taken from below); prone position.

the apex of the heart, where there is a greater mobility, at least in the horizontal plane. The prone position shows a large surface of the right and left ventricles in close contact with the chest wall and the lungs widely apart; in the other position, the heart is almost entirely to the left of the mid-

Fig. 2.—Tracing from a photograph of a frozen section; left side position.

dle line, whilst the right lung extends across to the left side, and envelops the organ closely.

An examination of a large series of sections points to the same conclusions, and illustrates the service of the prone position in bringing a larger area of the heart's surface into close proximity to the chest wall, and therefore more available for accurate percussion. It shows, moreover, the advantages of the prone position over left side recumbency, and it is quite clear that the latter possesses little value for the purpose of percussion.

METHOD OF CARRYING OUT PERCUSSION.

The observer is met at the outset with the difficulty of making an examination of a patient in the prone position with ease and comfort. Theoretically one would expect the action of gravity would best be obtained by having the individual perfectly flat on the face. This may be arranged by having two tables with a gap between to allow a view of the precordia. Here the body is at complete rest, the muscles are relaxed, and the full influence of gravity called into play. But percussion must necessarily be conducted in a cramped attitude from below, and it is obvious that this position, however great its advantages, cannot be regarded as practical. A more convenient method is to have the patient on the hands and knees on a table. The observer is then at a higher level, the cardiac area is fully exposed, and percussion more easily carried out. For ordinary work, a compromise may be adopted by having the patient standing and stooping forwards with the hands resting on some support. I have used this position in the out-patient room for three years, and have found it of considerable service. In a patient confined to bed, the sitting posture, with the trunk bent forwards, will generally be sufficient. A useful way to obtain the effects of gravity is to place the individual on a ward locker in the form of a high back chair so that he may stoop forward and support himself with his hand (Fig. 3). He is then at a higher level,

Fig. 3.

and percussion may be performed with more comfort to the observer. The left arm of the patient may be placed loosely behind the back, as this relaxes the pectoral muscles which seem to me during contraction to increase the sense of resistance and affect the note. In the stooping posture it should not be forgotten that the act of flexing the body forces up the diaphragm so that it stands at a higher level than usual. This is no disadvantage, as it will throw the heart more forward, and will, if anything, tend to enlarge the area of dulness presented to percussion. In fact, we may recognise several causes which co-operate in increasing the precordial dulness in this posture. There is the influence of gravity—the heart by its own weight falling forwards. Then the forcing up of the diaphragm occurs to some extent, and finally the excursion of the anterior wall of the chest is re-

stricted, and it does not move so much forward during respiration.

THE PERCUSSION AREA IN THE PRONE POSITION.

The influence of gravity, we have seen, results in the exposure of a larger area of the heart directly to the chest wall, and we find clinically that the area over which a dull note is obtained is definitely increased. I do not propose to enter into the distinction between relative and absolute dulness as modified by the effect of posture. Theoretically the relative dulness in the prone position should undergo but little variation, as that area is supposed to represent the anatomical limits of the heart. We know, however, as a matter of practice that the boundaries are exceedingly difficult to define absolutely, and if we cast aside preconceived ideas and enter on the examination with an open mind (which is admittedly difficult to do) we shall find our results by no means constant. Anyone can test this by the simple expedient of percussing the cardiac area blindfolded, and in a short time making a second observation under similar conditions for comparison. These remarks apply with perhaps greater force to the boundaries on the upper and right sides. The base of the heart lies deeper than the body and apex, and is covered by a greater thickness of lung. The right boundary cannot be determined with any great degree of accuracy on account of the note given by the sternum which masks that of the heart underlying it. We have not infrequently over the lower part of the bone a clear resonant note where it is obvious a considerable part of the right ventricle lies beneath. This effect of the sternum may be demonstrated in cases where that bone is abnormally short. In those we may have a clear resonance over the lower sternum, while immediately beyond the lower margin of the bone the right border of the heart may be noted to go as far over as the right sternal line. It will be granted that the assumption of the prone position does to some extent lend aid in ascertaining the deep boundaries of the heart. As the superficial dulness is definitely increased the shading off in the relative note is not so gradual, and we shall see later that there is reason to suppose that the difference between the two areas is not great. Repeated observations were made over an extended period of time on the deep boundaries with the patient in the stooping posture; in some instances material help was given, and this was so in a marked manner in individuals with emphysematous lungs, where no outline would be made out with the patient in the ordinary position. On the whole, however, the sources of fallacy in percussing the relative dulness were not removed, and it was found better to adopt the absolute dulness in which observation is less likely to err.

An examination of a large number of healthy individuals of different ages and sexes was carried out, and in not a few repeated at intervals. The method adopted was to percuss the absolute dulness in the erect posture and record it in an outline form. The individual was then placed in the stooping posture and any alteration in the area noted and recorded. The results over a series of cases agreed in the main, and the general outline of the increased area may be represented by the diagram (Fig. 4 on p. 138), which was taken from a young adult.

Taking first the alteration in the cardiac impulse, it was found in the majority of cases that it moved outwards in the prone position and at the same time became more diffuse. It was frequently palpable outside the nipple line where in the erect position it was quite within that limit. The average extent of its excursion ranged about half an inch, in some individuals being much greater, while in others little or no displacement was shown. In character it became less pronounced and not so forcible. This may be due to narrowing of the intercostal spaces from approximation of the ribs, which prevented the cardiac thrust being palpable over so large an area of intercostal space as in the upright position. The limits of absolute dulness underwent considerable change. The upper and left border, which may be considered as one, curved from just above the junction of the fourth left costal cartilage with the sternum, outwards close above the upper margin of that rib, then downwards and slightly outwards to the position of the impulse in the line of the nipple. In young subjects this border may sometimes reach almost to the lower border of the third rib, and on the other hand in elderly people it may

scarcely attain the fourth rib. This border is by far the most important one to map out with accuracy, as it gives a clearer estimate of the condition of the heart. The right border coincides as a rule with the left lateral sternal line; sometimes it extends out to the sternum, but it is usually impossible to obtain a trustworthy result over that bone from the presence of its own resonant note. The lower limit cannot be distinguished from the upper margin of the liver dulness.

Such is an outline of the area of dulness which may be observed in healthy individuals in the prone or stooping posture, and it is of interest to compare the limits of the heart as ascertained in the ordinary position. For this purpose I have introduced an outline diagram (Fig. 5) from Vierordt's *Medical Diagnosis*, a standard work on the subject. It will be seen that the absolute dulness in the stooping posture approxi-

Fig. 5.

Fig. 5. Normal percussion figure of the heart from Vierordt's *Medical Diagnosis*. Light shading represents relative dulness.

Fig. 4.

Fig. 4.—Outline of percussion area from a man 26 years of age. Light shading represents increased dulness in stooping posture; x x the cardiac impulse in different postures.

mates very closely to the area of relative dulness as percussed by the ordinary method, the only difference of moment being a somewhat wider limit for the upper and left boundary in the latter. The shoulder, so to speak, of the margin does not move out so clearly in the stooping posture, a modification which is readily explained by the base of the heart having a more limited range of movement and not coming into such close contact with the chest wall as the body and apex. On the whole, however, I think it will be conceded that the resemblance is sufficiently close to enable one to draw an accurate estimate of the anatomical limits of the heart from information afforded by the absolute dulness of the prone or stooping position.

With regard to the advantages of this method of examination, I believe it will be found to be much more precise than the estimation of the relative dulness in the supine position, inasmuch as it can be carried out by a lighter stroke and the percussion note is more definite. We avoid those transitions of sound which easily lead to error and which are scarcely to be recognised even by long training and the most practised ear. The constant variation in the pulmonary borders is largely eliminated, and having to deal with an increased area giving an absolutely dull note, the accuracy of our percussion is greater and observation is less likely to err. Lastly, there is a further advantage which has been pointed out by Gumprecht in that it brings out an area of dulness which may be quite impossible to ascertain in the supine position. In tympanites of the stomach and colon I have on more than one occasion experienced difficulty in determining the cardiac area until the patient was placed in the stooping posture.

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MEDICAL MAGISTRATE.—Dr. John Griffith Lock, J.P. for the Borough of Tenby, has been appointed by the Lord Chancellor, upon the recommendation of the Lord-Lieutenant, to the Commission of the Peace for the county of Pembroke.

PERICARDITIS IN RHEUMATOID ARTHRITIS.

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THE question of heart affections in rheumatoid arthritis is one which has given rise to much discussion. While endocardial lesions are found with a comparatively greater frequency than those of the pericardium some doubt has always existed as to their origin and nature. The same may be said with greater truth about pericardial lesions, and for this reason I think the two following cases may be of interest. In both we have the occurrence of an acute pericarditis during the course of rheumatoid disease, and presumably, therefore, intimately connected in origin with it.

CASE I.—R. D., aged 24, tailor's assistant, married, was admitted to the Bath Mineral Water Hospital on January 25th, 1896, suffering from rheumatoid arthritis. Her family history was unimportant, whilst her previous history had been distinctly good. She had been married two years and had one child twelve months old. Her confinement was natural and uneventful, but a month after she caught cold, and pain came suddenly in both knees, then in her ankles and feet, and spread rapidly to her hands, wrists, and shoulders, and quite recently to her elbows, jaws, and neck. Her condition had steadily been getting worse. On admission she was found to be a rather badly nourished woman, who was losing flesh fast, and whose temperature was never quite normal. Otherwise her general health was fair and her appetite good. Menstruation was scanty and irregular. On examination the heart's apex was found in the fourth interspace in the nipple line. It was heaving and diffuse. The cardiac area of dulness was increased slightly in all directions. A loud systolic and a post-diastolic murmur was heard at the apex, with accentuation of the second sound at the base. The joints most affected were those of the fingers, the wrists, the jaws, and the neck; the shoulders, elbows, knees, and ankles to a less extent. There was marked muscular wasting of the interossei and extensor muscles of the forearm and hand. There was sweating of the hands and pigmentation of the skin of the forehead, hands, and forearms. The hands and feet felt cold, and looked blue, and the axillary glands were enlarged, but there was none of the spleen. The pulse was 86 and the temperature 99.2°. The urine contained neither sugar nor albumen. Under treatment she progressed slowly, if at all. On February 16th, three weeks after admission, she complained of pain in the chest, and the temperature was found to have risen to 101.4°. Loud pericardial friction was detected over the second left cartilage, her pulse was quick, and there was some difficulty in breathing. From the 16th to the 25th the friction extended, and finally could be heard all over the cardiac area, her temperature meanwhile ranging from 99° to 103°, and her pulse from 100 to 140. During the evening of the 25th she complained of a short hacking cough, and she became slightly cyanosed. Over both apices there was slight loss of resonance, with some bronchial breathing and fine inspiratory crepitations were detached. On the 26th the expectoration, which was difficult to bring up, was rusty in character, and her temperature remained about 102°. On the 27th the heart's action was very irregular and feeble, and there was oedema of feet and legs. A trace of albumen was found in the urine. On the 28th, although the breathing was still rapid, it was not so laboured, the expectoration had become frothy, her pulse was more regular and the temperature was slightly less, as was also the oedema. On the 29th she felt better, and about midnight she became much easier, her breathing became quiet and less hurried, her pulse more regular, and her temperature fell to normal within a few hours. During March 1st she continued better, but on the 2nd she complained of some pain between the shoulders, and had diarrhoea, whilst a rash appeared on her hands. This latter was bright red in appearance, slightly raised, and seriginous in outline. Her temperature, too, rose to 101.4°. On the 3rd she was better, her breathing easier, and in no pain. The rash began to fade. On the 4th she continued better, and on examining the chest it was found that the symptoms were rapidly clearing up, and that the pericarditis was practically gone. From that date until her discharge, on the 28th, she progressed rapidly, getting stronger and better every day. The lung and heart mischief especially cleared up in a wonderful way. The murmurs, however, persisted, but they, too, were less intense in character. The joint symptoms from the onset of the pericarditis improved rapidly until all swelling and pain had nearly gone, and this continued until her discharge, when the hands were no longer asphyxiated in appearance, nor were they cold or wet. A certain amount of deformity still remained, but for all practical purposes the condition appeared to be cured.

CASE II.—G. H., aged 37, labourer, was admitted on January 3rd, 1896, suffering from rheumatoid arthritis. His family history showed phthisis on the maternal side, but his previous history was good. His present illness began thirteen months ago, after an attack of influenza and tonsillitis, with stiffness and pain in the right thumb, which soon spread to all the joints of both hands, to the knees, and later on to shoulders, elbows, wrists, jaws, and back of neck. On admission he was found to be a badly nourished man with fair appetite, bowels constive, but fast losing flesh. Within the last few weeks he had got rapidly worse. On examination, the heart's apex was found in the third interspace ½ inch internal to the nipple line. The first sound at the apex was impure, but no distinct murmur. He had considerable swelling of the joints of the fingers, of the wrists, and knees, the other joints being affected to a less extent. Both hands and feet were wet with perspiration, and there was marked pigmentation, with wasting of the extensors of the arms. On January 7th he developed a herpetic eruption along the course of the right ilio-inguinal nerve, his general condition meanwhile remaining much the same, except that the temperature, which on admission was 99°, rose to 100°. For several days this persisted, and he suffered much from pain