tube. It is best to give the patient plenty of fluid some time before the examination in order to excite the renal function. I have for long relied upon half a bottle of Contrexéville water

Fig. 3.—The Nitze Catheter entering left Ureter.

Fig. 4.—Cystoscopic picture of a Casper catheter entering mouth of right ureter.

taken an hour before exploration. Cocaine is ample in most instances when the urethra is tolerant and capacious. If an anæsthetic is needed chloroform is perhaps more suitable, as it interferes less with the rapid secretion of the kidney than ether (?).

RAPID DETECTION OF THE SITE OF THE URETER MOUTH AFFORDED BY STAINING THE EFFLUX WITH ANILINE DRUGS.
When the bladder base is much swollen or the ureteral orifices are displaced, or the kidney is sluggish, or herniæ coexist, difficulties may arise. In detecting the mouths of the ureters and distinguishing a thin-edged patulous orifice from a minute hernia the value of a stain for the urine will be obvious. I have for some years made use of fuchsin ($\frac{1}{2}$ gr. in pill). This, if taken an hour or so before the examination, will colour the urine a delicate pink, so that after the bladder has been washed out streams of pink urine will be seen to issue from the ureters. I may be permitted to remark that fuchsin does not affect some kidneys at all, and others which are undoubtedly weak pass a good deal of the colour through. Some years ago I hoped to be able to test the efficiency of the secreting cells by means of fuchsin, but extended experience showed me the test was unreliable.

SOUNDING THE KIDNEY PELVIS AND URETER FOR STONE UNDER ELECTRIC LIGHT.

Before the male ureter could be catheterised under the light, I used to have the female ureteral catheter tipped with metal for sounding the female ureter, for the fingers can detect by these means the presence of any small calculus in the channel of the ureter. Sounding the ureter is difficult in the male because of the many bends the catheter has to make and the many corners it has to pass; the gripping and friction of these tend to obscure the sense of touch. But there is no doubt in my mind that this is a step in the future.

The microphone perhaps may render it of more value. I believe that ureteral obstructions from kinks and stones are more frequently the cause of renal pain and colic than is at present allowed.

ON THE CAUSE OF DEATH BY ELECTRIC SHOCK.

BY
THOMAS OLIVER, and ROBERT A. BOLAM,
M.A., M.D., F.R.C.P., M.D.,
Professor of Physiology, Joint Lecturer in Physiological
Chemistry and Physics,
University of Durham, College of Medicine, Newcastle-on-Tyne.

THE increasing employment of electricity within the last few years has demonstrated, from the accidents to workmen engaged in its generation and distribution, not only what a dangerous force it is, but the necessity for using all the precautions suggested by experts. In this country alone within the last few years, sixteen deaths have been caused by electricity. It has seemed to us, therefore, that the present time is opportune for reopening the subject with the view of ascertaining the cause of death in such cases.

A powerful electric current kills immediately. Two opinions are before the profession (1) that death is due to failure of the respiratory centre (d'Arsonval) (2) that it is due to sudden arrest of the heart's action. From the appearance presented by the internal organs after death some physiologists have maintained that death is due to asphyxia. We have it on the testimony of workmen employed in electric generating stations that when one of their mates has been fatally injured by coming into contact with highly charged metal, he has generally breathed a few times although to all appearance dead. This fact, therefore, would suggest that death was not due to failure of the respiratory centre. To what other cause may it be attributed? It is desirable that a definite opinion, if possible, should be arrived at as to the cause of death in electric shock, so that we may have at our command means for the resuscitation of those who have been apparently killed by such discharge. As this subject formed part of an inquiry by a Home Office Committee upon which one of us served, and for which we instituted a series of experiments upon animals, most of them under anæsthesia, with the view of determining these points, we feel that the data thus obtained have a scientific not less than a practical value, and as such we offer them for consideration.

The animals employed in this research have been dogs and rabbits. In almost every case ether was used as the sole anæsthetic. The blood pressure was recorded in the ordinary way, the left femoral artery being usually opened in the dog, the left carotid in the rabbit. Respiratory movements were registered by means of a Verdin's double tambour applied to the chest of the animal, and communicating with a recording tambour. When artificial respiration was used in the attempts at resuscitation after shock it was generally performed by the Sylvester method; occasionally by inflation through the usual tracheal cannula inserted at the outset of the experiment. An alternating current supply in the laboratory running at 100 volts and 100 cycles per second was transformed as required. Wet sponge electrodes mounted on 6 inch vulcanite handles for efficient insulation were applied to the fore and hind limbs on portions of the skin previously shaved and thoroughly moistened. The period of stimulation was shown by an ordinary time marker on a shunt circuit in which were placed two incandescent lamps in series. We would take this opportunity of cordially acknowledging our indebtedness to Mr. R. J. Patterson, Lecturer in Physics, Durham College of Science, for much help in the physical portion of the work as well as for personal aid in many of the experiments.

RESULTS.

When an animal is exposed to electric currents of sufficiently high potential death, practically speaking, is instantaneous. The animal is thrown into a condition of opisthotonos, during which breathing is suspended; the heart's beat momentarily quickened and then arrested, while with currents of somewhat higher potential still it is immediately arrested without any preliminary quickening. On shutting

Fig. 2.—A current of 50 volts induces similar but more pronounced respiratory disturbance, and there is now evidence that the heart is affected. The initial rise of arterial pressure gives place to a downward curve of diminished tension, broken by a few elevations denoting imperfect heart contractions with much lengthened intervals between the enfeebled beats. On breaking the circuit the heart recovers, and the vascular tension rapidly regains its normal state. With a doubled potential (100 volts) an exposure of two seconds to the current proves fatal. The respiratory curve exhibits much the same character as before, but the line of blood pressure elevated at the outset rapidly falls, and the descent is not broken by any heart beats. Gradually diminishing oscillations caused by respiratory efforts mark the pressure curve, but these finally disappear, respiration still persisting long after the heart has ceased to beat.

Fig. 3.—Dog, terrier. Fick's kymograph. Cannula in left femoral. Currents of 25 and 50 volts show vascular and respiratory effects, similar to, but less marked than in the rabbit. In this instance 100 volts proved fatal. The blood pressure curve presents the same features as in the smaller animal, and respiration is seen to continue for some 45 seconds after the cardiac arrest.

Fig. 7.—Dog, mongrel. Mercurial kymograph. Cannula in left femoral. This tracing shows the rapid fall of blood pressure when a lethal current passes. No heart impulses can be seen on the downward curve, and the influence of the irregular respiratory efforts grows less and less as the pressure sinks to zero. Breathing is continued for thirty seconds after the circuit is broken.

off the current there occurs a deep inspiration, usually followed by an expiratory cry. When a serious accident from electricity has happened, it is this "cry" which is heard by workmen, and which attracts them to the spot where the apparently lifeless body of one of their comrades is lying. Dogs, through which a powerful electric current has been passed, may, on breaking the circuit, not only breathe spontaneously and rhythmically for several seconds (even a minute or two) but bark loudly, and yet all the time the heart has ceased beating. Whilst in some of our experiments death seemed to be due to contemporaneous cessation of the respiration and heart's action, yet in most there was ample demonstration that the organ first to be arrested was the heart, for breathing was observed to continue rhythmically for a brief period, and then irregularly and feebly before stopping. We have reason to believe that only in the case of very high voltages with currents considerably above the potential usually required to kill the animal is there simultaneous stoppage of heart and respiration. Primary cessation of the heart's beat is without doubt the general rule, while under no circumstances have we succeeded in causing primary arrest of respiration followed by failure of the heart.

The accompanying tracings are selected to elucidate some of the chief phenomena observed during and after the passage of the alternating current in animals. The uppermost curve in all the tracings is that of blood pressure, the middle that of respiration, whilst the lowest indicates the point and duration of each electrical discharge.

Fig. 1.—Rabbit, male. Blood pressure by Fick's kymograph. Cannula in left carotid. The passage of a current of 25 volts for two seconds causes marked inspiratory spasm with concomitant rise of blood pressure. The heart's action is not disturbed. A series of deepened respirations ensues upon shutting off the current.

Fig. 4.—Dog, terrier. Mercurial kymograph (Verdin). Cannula in left femoral. A 60 volt current causes only slight rise of blood pressure, with a subsequent fall, also slight.

The changes in arterial tension are more strikingly exhibited when the mercurial manometer is employed to register the blood pressure.

The resemblance of the blood pressure curves in these cases to those obtained on vagus stimulation is striking and suggestive. So far, however, the results furnished, both after sec-

tion of the vagi and after injection of atropine, give no support to the supposition that pneumogastric impulses account for the inhibition of the heart observed. We are led on the other hand to believe that the effect of the current is directly upon the heart itself. Our opinion as to the cardiac cause of death received confirmation from the evidence gained by auscultation of the chest of the animal during and after the passage

Fig. 5.—With 100 volts we see the initial rise followed almost immediately (and while the current continues to pass) by a rapid fall practically to zero. At the break of circuit, pressure rises by rapid leaps, attaining almost to the previous normal level. A gradual diminution of tension then takes place, followed by a somewhat slower rise up to or beyond the usual limit.

Fig. 6.—In the case of 150 and 166 volts the same features present themselves in exaggerated form. It may be noted in the latter instance that the respiratory lever falls with forced expiration when the current is cut off, only to at once rise again with the inspiratory gasp previously commented upon. Thereafter the tracing denotes further pronounced expiration, a period of rest in the position of extreme expiration, and finally gradual return to the usual characters.

of the current. The heart's sounds indicated momentary quickening and even irregularity in the case of currents of low voltage, but with higher voltages instant cardiac arrest was the striking feature. On breaking the circuit the chest walls would rise and fall in respiration, and the respiratory murmur be pronounced, without any return of the heart's sounds being observed. We considered it advisable to control this result by direct inspection. To this end the heart of the

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.

By DONALD ROSE PATERSON, M.D., M.R.C.P.,
Assistant Physician, Cardiff Infirmary; Honorary Physician, Hamadryad Seamen's Hospital; Lecturer on Materia Medica and Pharmacology, University College of South Wales.

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