efficacy. Schizophrenia causes the death of the nervous system in as large a percentage as an intestinal carcinoma would cause the death of the body.

If convulsion therapy is really of unique value as a curative agent we should not be justified in withholding it on account of these non-lethal dangers any more than we would deny our cancer patients the chance of a major operation. Of the curative effects of these electrically produced fits we would prefer to say nothing at the present moment. Just as with cardiazol, we have seen some marvellous recoveries which the clinician could only attribute to the treatment itself, but the time has not yet come to assess the statistical value.

In conclusion there is a rather interesting feature of the post-epileptic's behaviour which may prove to give some indication as to the mechanism of the curative action of the fits should it exist. Every patient has his own stereotyped manner of behaviour in the post-epileptic stage. Some indulge in rhythmic movements, some always repeat the same utterances, others turn over and go to sleep, others become aggressive or, in rare cases, maniacal. In each the particular type of post-epileptic conduct remains constant until general clinical improvement has become manifest. We have never seen any serious symptoms of respiratory failure of cardiac distress.

The necessary apparatus can be cheaply constructed, and the running expenses are nil compared to the use of expensive drugs. Unlike insulin the electrical treatment does not call for technical skill on the part of the assistant staff.

The Clinical Applications of Electrically Induced Convulsions

By W. H. Shepley, M.B., D.P.M., and J. S. McGregor, M.B.

Our apparatus and technique are modifications of those used by Cerletti and Bini (1938) and similar in description to those described by Fleming, Golla and Walter (1939). The apparatus is wired in two circuits, one a low-voltage direct current circuit for measurement of the patient's head resistance, the other an alternating current circuit, giving a voltage which can be varied between 50–150 volts. The low-voltage circuit gives a current of one milliampere. To sensitive patients even this small current can be unpleasant if applied suddenly; therefore it is gradually applied to the head by means of a potentiometer whereby no complaint of tinglings or other sensations arises. The resistance of the head is read on a scale round the knob of the potentiometer. Another feature is that the low-voltage circuit can be made independent of mains fluctuation, a fluctuation in the order of from 6–7%, avoidable by means of a standard resistance which can be inserted into the circuit. In this way the feeding voltage of the potentiometer is kept constant, and the obtained resistance values are not subject to any fluctuations. The time during which the current is allowed to flow is predetermined on a time-switch of the condenser type. This gives readings of 0·1 to 0·5 of a second. The current flowing through the head is measured in milliampere-seconds on a meter employing the ballistic principle so as to permit the reading to be taken when the needle reaches the maximum of its excursion. The reading, divided by the time, gives the current in milliamperes. The electrodes consist of silver-plated strips of flexible copper, mounted on rubber cushions fixed to an adjustable clamp. The area of the electrodes is about 38 sq. cm.; therefore the current density at any one point is never very high, being less than the average current recommended for use in diathermy. Before application to the head the electrodes are covered with linen which is soaked in a 20% solution of NaCl.

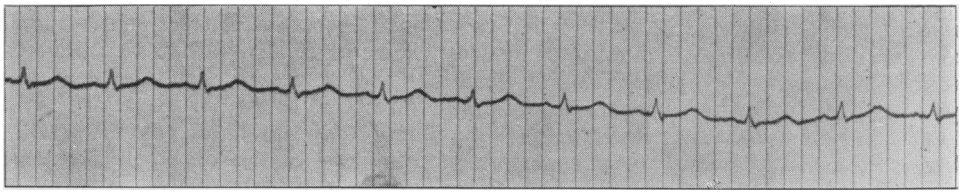
They are applied to the head at the junction of the parietal and temporal bones, over which site a contact paste has been smeared. This ensures good contact between the electrodes and the scalp and helps to ensure that conduction will not take place to parts other than the head. It is interesting to note that if the chin or head is touched a shock may be felt, but not from any other part of the body. It appears to us that the time during which the current is allowed to flow is a more important factor in the induction of a fit than is voltage, for we have frequently been able to obtain a major fit by increasing the time when an increase in voltage had proved ineffective. The reason for this appears to be that when time is increased the number of stimulations reaching the cortex increases proportionately. Nevertheless we hold the view that the fit might be induced either by a high voltage for a short time, or by a low voltage for a longer time. As to which of these methods is the more desirable is a question to be decided by physiological experiment, preferably other than in man. The voltage ordinarily used by us ranges from 100–120 volts, the time 0·2 second. The effect of the passage of the current is to induce either a major fit or merely transitory loss of consciousness—the so-called abortive fit. When no fit is obtained by the first shock, there appears to be no contra-indication to reapplying the electrodes and making another attempt. When this is done it is observed that there is a fall in the head resistance. This fall appears to be progressive following each successive shock until a mimimum in the region of 100–200 ohms is reached. The reason for this is not clear, but it is possible that it is the result of tissue electrolysis. We have in the case of one patient made six successive shocks before the major fit was obtained. There was no protest from the patient and so far as could be observed no ill-effects. In the major fit evacuation

TABLE SHOWING EFFECTIVE INDUCTION OF FIT BY INCREASING TIME.

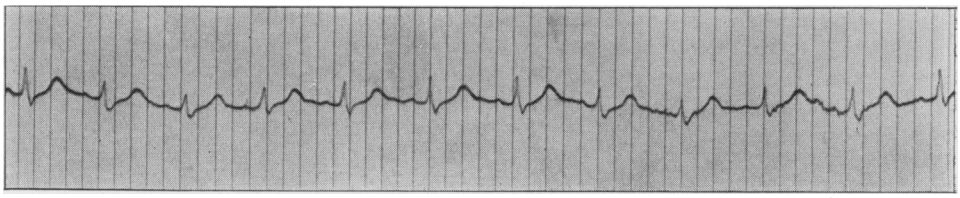
Date	Time	Resistance	Volts	Milliamps	Fit
2.12.39	0·1 sec.	750	85	450	—
2.12.39	0·1 sec.	550	95	600	—
2.12.39	0·1 sec.	420	120	900	—
5.12.39	0·15 sec.	500	120	850	—
5.12.39	0·20 sec.	250	120	900	+

of urine or fæces has been observed, as also has seminal emission. The effect of an abortive shock upon the patient varies considerably, from momentary loss of consciousness to generalized tonic spasm of muscles with slight opisthotonus and opening of the mouth, though the further stages of a major fit do not follow. It would appear that anticonvulsant drugs such as paraldehyde, have the effect of increasing the patient's resistance to the current. One of our patients who had 3 drachms of paraldehyde, together with 30 gr. of sulphonal the night before treatment, required a much higher current than usual before a major fit could be induced, and a similar result was noted on subsequent occasions. Another patient was given one capsule of epanutin for three days before treatment and the voltage had to be increased by 10 volts to induce the major fit. This patient had previously shown major convulsion consistently with the same voltage and time. This compares with the observation of Cook (1938) that a larger dose of cardiazol was necessary when such drugs had been administered. The effect of application of the current on the heart has been observed, and it appears that at the moment of passage of the current the heart stops ; the exact duration of this pause cannot be estimated, for almost at the same moment there is some movement on the part of the patient so that further observation either of the pulse or cardiac sounds is rendered impracticable, and it is of course impossible to take an electrocardiogram during the passage of the current. Electrocardiographic records have been made in some patients, both before and after the shock, and it is

of interest to note that there is an increase in the amplitude of the ventricular complex of the order of 0·2 of a millivolt in records taken three minutes after the shock. Indeed, in the flaccid stage immediately after the fit, this increase was so great that the beam of the cathode ray of the electrocardiogram left the fluorescent screen. While the reason for this is not clear, it may be, as suggested by Fleming, Golla, and Walter (1939) in the case of the electro-encephalogram, that not only the head but also the body becomes charged in the nature of a condenser. We have applied the method to patients in insulin coma, without untoward result. In these cases we take the precaution to see that patients in the so-called wet coma are sponged dry. The normal dry skin is a poor conductor of electricity and MacDonald Critchley (1936) quotes that the dry, horny palm of a workman has a resistance of from 1 to 2 million ohms. Notwithstanding, under circumstances favourable to the passage of the current, comparatively small voltages, in the region of 100, have proved fatal. It is well known that many electrical accidents occur in the bathroom when a short-



E.C.G.—Lead I. Before shock.



E.C.G.—Lead I. Three minutes after fit, showing increased amplitude of Q.R.S.

circuited switch has been touched by a wet hand. We therefore see to it that pillows and bed linen, if moist with perspiration, are changed. With non-insulin patients the major fit most commonly occurs immediately, or within a few seconds, though we have noted a delay of thirty seconds in several cases. A delay of thirty seconds in coma patients is, however, common, or even as long as one and a half minutes. The reason for this is probably that cortical activity depressed by the action of insulin takes a much longer time to respond to the number of stimuli applied to it by the alternating current. Commonly, too, the fit is atypical. One of our cases had on two occasions a fit almost confined to the left side of the body. This began with clonus of the circumoral muscles and spread to involve the left arm and leg in clonus. There was no obvious tonic stage. The pupils, commonly small and occasionally fixed before the application of the current, dilate fully, and the light reflex is lost. Some cases immediately after the shock become slightly cyanosed and this deepens until the face becomes almost purple, and then the major fit occurs after a delay of about fifty seconds. An interesting feature of the application in insulin coma

is that when several shocks have been given without the induction of a major fit, there is a tendency for the patient to come out of coma, and this is reflected in the blood-sugar which shows an increase of about 15 mgm.%. We have not chosen any particular time after the onset of coma, for application of the shocks, though Georgi (1937), who introduced the summated method of treatment with cardiazol, suggested that it should be done from one to two hours after the onset of coma. The time selected and the depth of coma appear to make little difference to the results of application of the shock. It has also been noted that after the shock, bile, absent in the gastric juice before the shock, now becomes present in fairly large amounts. It has been suggested by Cerletti and Bini, also by Kalinowsky (1939) and others, that the area of the brain stimulated is the Vogt-Brodman area 6aβ. While this area certainly seems to be the one mainly involved, the presence of bile in the gastric juice after a shock, even when no fit is induced, and the frequent development of a dusky cyanosis of the face after an abortive shock, suggests vagal activity consequent upon stimulation of the medulla.

Our 50 cases already treated by the electrical method were for the greater part cases of long standing which had failed to respond to cardiazol treatment, others were drug-convulsant cases now continued by electrical means. From this limited number, admittedly too small for any conclusions to be drawn, certain indications appear. The cases which had previously failed to respond to cardiazol, equally have shown no response to electrical treatment, nor does it appear likely that they will. Cases which had previously shown response to cardiazol or triazol, equally appear to respond to electrical treatment. These include cases of katatonic schizophrenia, schizophrenic reactions of exogenous type, one a recurrent post-puerperal katatonic stupor, pregnancy twice having appeared in causal relationship, also certain depressives including agitated melancholias, together with cases of paraphrenia, recurrent mania, and hysteria. An interesting group consists of five patients who had previously responded to cardiazol but had consistently relapsed if treatment was withheld for longer than a fortnight. These patients appear to require a " maintenance " treatment to prevent certain relapse. Hitherto this matter of indefinite continuance has presented a difficult problem because of the dread of treatment, especially of a treatment without apparent end-point. These five individuals approximate to the katatonic schizophrenic type without appreciable mental deterioration, so that they attain normality apart from their psychotic phases in which dyskinesia is an outstanding feature. They have been found to respond equally to electrical treatment without the accompaniment of fear. This feature of " maintenance " treatment by the new method appears to open up interesting possibilities for out-patients' clinic application, since provided the patient is willing to attend for periodic treatment, resumption of ordinary outside life appears possible. This possibility is furthered in two directions, namely, the removal of fear which otherwise would render voluntary attendance beyond expectation, and the absence of " after-symptoms ", such as vomiting, confusion, and excitement, which have hitherto required confinement to bed for an hour or more and a close nursing supervision. That the therapeutic results of the method described must stand or fall with those of shock therapy in general, we are agreed. The indications and contra-indications appear essentially similar, as also is the preparation of the patient. In furtherance of Dr. Skottowe's " Plea for Proportion in Psychiatry ", where shock therapy is concerned, we would attempt some review of apparent indications and contra-indications as they appear to us. Upon a wider basis of clinical experience of shock therapy in general, including 250 cardiazol treated cases and 50 treated by insulin, it appears possible to indicate broadly certain cases which do not respond and those in which treatment appears likely to be beneficial. It is generally admitted that for the most part chronicity is of unfavourable import where shock treatment is considered. Those cases which

tend to recover spontaneously may recover more speedily given shock treatment. What to-day is described under the term of the Schizophrenias is a group so wide as to be in danger of losing precise meaning. It appears fundamentally important to differentiate between the true endogenous malignant schizophrenias and the relatively benign exogenous reaction types, many of which are recoverable. Among the shock-resistant cases we find the true endogenous schizophrenias, well termed dementia præcox by the older clinicians. These occur in individuals of pronounced constitutional inferiority with poverty of organic endowment. They are marked by physical signs of cardiovascular hypoplasia and hypofunction, together with general asthenia, poorness of sex differentiation, and consequent physical tendencies towards those features, the presence or absence of which characterize the opposite sex. These circulatory and endocrine features were well described by Lewis (1923). Such individuals morphologically tend towards the asthenico-athletic or less commonly the dysplastic types of Kretschmer, but morphological considerations alone are not sufficient to differentiate them, since function and capacity to react are more important than structure. Physical signs such as persistently cold, blue extremities even in warm weather, denote poorness of peripheral circulation and inherent lack of vitality. Examination by orthodiagraphy shows smallness of the internal viscera, in particular the heart and aorta, the latter tending towards smallness of calibre. Such findings are confirmed by post-mortem examination and are characteristic of dementia præcox, which *per se* is a sufficient certifiable cause of death. Mentally such individuals show emotional poverty and apathy, the negative aspects of mentation outweighing the positive. In such individuals the prognosis from the first appears unfavourable, and in their varying degrees they form the larger proportion of our chronic mental hospital population. In our experience they are quite unresponsive to shock therapy, appearing to lack the essential capacity to react. A further group which appears therapeutically resistant consists of the fixed delusional classes whether paranoid dementia, paraphrenia, or paranoia. Of these, however, the two former may at least be relieved of hostility and be rendered more accessible and sociable. There is nevertheless at least one exception to the above generalization ; that is, where the delusion is the direct outcome of altered feeling-tone such as occurs in certain depersonalization states of depression : here, convulsion therapy has proved capable of removing even a fixed delusion. Such was the case where a female patient steadfastly declared for a period of months that she was made of wood. This delusion speedily disappeared following cardiazol exhibition. True manic-depressives of affective cyclothymic type characterized by periodic elation and depression are definitely rare in mental hospitals, but when they occur, they approximate to Kretschmer's pyknic type as regards habitus. Like the schizophrenias, they appear to occur in both endogenous and exogenous forms. Irrespective of causation these cases are essentially reactive, in the sense that sensory stimulation results in ready motor response ; and in such, cumulative inhibition does not readily occur. Clinically they do not show the features and extremes of inhibition and excitement in marked degree, but rather phases of irritability and agitation, or alternatively a quiet melancholy or mildly demonstrative elation. The term " manic-depressive ", although properly applied to these, appears nevertheless unfortunate, since the term suggests the more obvious extremes of excitement and inhibitory depression such as characterize the dyskinetic schizophrenes with all-too-frequent confusion. As regards convulsion therapy, these affective cyclothymes tend to react badly, not infrequently showing pallor, rapid feeble pulse, and signs of physiological shock. Such signs appear accountable to their relatively large splanchnic area in these individuals of pyknic body type. Essentially they are not of cortical inhibitory type and in them convulsion treatment appears generally to be contra-indicated. To turn now to indications for convulsion treatment in particular, as apart from

shock therapy in general, which of course includes insulin, a review of our successes makes clear especially that those cases which can be grouped as " inhibitory " in the physiological sense are of favourable import: it is a group largely composed of dyskinetic schizophrenes. These include cases of stupor, both depressive and katatonic, and a wider group of what may be termed schizoid depressives, individuals with less marked motor manifestations, but whose depression is characterized by peculiar persistency and malignancy of quality. That the excitatory counter-phase of katatonic stupor, and depression, should also respond, though less conspicuously, seems understandable as furthering a " release " phenomenon already begun. Whilst the above appear to belong to the same constitutional type, for the most part asthenico-athletic schizophrenes of good organic endowment, they may show not only alternations of phase, with or without intervening normality, but also predilection towards either extreme, inhibitory or excitatory. There are certain individuals in whom phases of pseudo-maniacal excitement marked by hypermotility recur every few weeks, but in whom no depressive phase appears. In such the intervening normality represents no more than that degree of inhibition which is the proper function of cortical control. To this condition the name recurrent mania is commonly misapplied but it is important to observe that true elation is not a feature nor indeed is any sustained affectivity. A seeming silliness of behaviour is however characteristic, and is resultant from disharmony between affect and ideation. The above described clinical picture clearly aligns these cases with the schizophrenias. They appear indeed to represent truly, acute schizophrenic episodes albeit of short duration; episodes interrupting normality and not featuring a continuous psychosis. Moreover they are seemingly constitutionally predisposed and endogenously determined. In such individuals this excitatory phase can be anticipated by induced convulsions towards the end of normality, or can be curtailed by such, on first appearance of relapse. There appears in short to be not only a broad basis of selection for treatment, but more precise indications regarding time of application and frequency of application relative to alternation of phase and the individual's response to treatment. We are conscious of the incompleteness of this brief survey, but submit that a study of basic constitution is an essential guide to case selection where shock therapy is considered, if such is to be more than a merely empirical procedure.

Conclusion

To revert to electrically induced convulsion therapy as compared with other methods, the chief points can be summarized as follows: The electrical method is well tolerated by the patient who is freed from the dread which hitherto was associated with these necessarily continued treatments. The disagreeable sequelæ of drug-convulsant treatment are notably absent, such features as vomiting, confusion, and psychomotor restlessness which formerly required close " after-supervision " are not evident. The method by its nature is devoid of such former technical complications as thrombosis of veins, a feature of a special importance where insulin is used either subsequently or in combination. The method can readily be combined with other treatments such as insulin, and being a physical therapy, removes all question of toxicity or cumulative action. In virtue of the last-mentioned facts, the procedure is completely controllable, a succession of fits not intended being unknown. The method is ideally suitable for the indefinitely prolonged maintenance treatment in those not-infrequent cases where an occasional convulsion is essential to prevent relapse. The method may well reduce the incidence of fracture since our impression is that the fits upon the whole appear less strong. In our series of some 200 induced major fits neither fracture nor dislocation has so far occurred. The method offers of ready repetition without the attendant difficulties of a struggling patient, and indeed the abortive fit induces quiescence and a ready acquiescence to further

treatment, in marked contrast to cardiazol administration under similar circumstances. From the administrative point of view the method offers advantages of economy, also less nursing attention and supervision.

It remains for us to thank Dr. Rees, Medical Superintendent of Warlingham Park Hospital, for suggesting the electrical treatment, and by his good offices making such possible.

To Dr. Kalinowsky we are indebted for practical aid and advice, freely given.

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Discussion.—Dr. L. KALINOWSKY : The first experiences with electric convulsion treatment (E.C.T.) in this country are of recent date. Professor Cerletti sent me a report on the two years' work done at his clinic in Rome.

The time of observation is still too short for a definite judgment. Figures of the immediate results have been given from a first series of 3,000 fits in more than 100 patients. In those cases where the duration of the psychosis was less than six months complete recovery was obtained in 80% ; the remaining 20% were much improved. The complete recoveries decrease, as in all the other shock treatments, with the increasing duration of the disease. In cases of one to three years' duration only a third showed recovery or was much improved. Still older cases showed improvement in 50% but never complete recovery.

As to the number of fits, the optimal effect was obtained in the first group of recent disease after 15 complete and four incomplete fits on an average.

I have not seen any striking difference in the quality of the results between the various groups of schizophrenia. From the beginning we have seen most surprising reactions in the depressive group of manic-depressive psychosis. Cerletti now regards his results in these cases as still more brilliant than in the treated schizophrenics.

Here are some results of early investigations : Accornero found a rise of systolic blood-pressure immediately after the fit by 50 to 60 mm.Hg and a fall to normal within thirty minutes. The diastolic pressure does not rise up to more than 10 to 15 mm. ; in other words the pulse pressure is considerably increased. These figures might be of still greater interest in problems of epilepsy than those from cardiazol fits.

The effect on blood-sugar was a rise by about 20% with a return to normal within two hours, but only when unconsciousness and not a real fit was obtained. Fractures and dislocations have never occurred, probably because the fit seizes an already unconscious and relaxed patient and not the severely struggling patient after cardiazol injection. Cerebral complications or mental sequelæ have never been seen during or after the treatment within the two years' application of the method. That there are no anatomical reasons to expect such complications is shown by Cerletti and Bini by means of extensive investigations on shock-treated animals. They found irreversible cell lesions in insulin-treated as well as in cardiazol-treated animals. But they never found any in dogs treated with E.C.T. ; here only reversible changes such as Nissl's acute cell disease were seen.

I think that the E.C.T. has proved its harmlessness by the fact that in Italy where the method is used in all mental institutions an enormous number of fits had been produced without any incident. This aim has been achieved by means of a standard apparatus introduced in England on the

suggestion of Dr. Rees by the " Solus " Electrical. Cerletti and Bini had an apparatus in mind which, without special knowledge of electrophysiology, can be employed with the same reliability by every doctor of a mental institution. In order to produce the fit with a minimum of voltage they constructed an often modified electrode which enables them to apply a very strong local pressure without inconvenience for the patient. In this way they get a very low resistance and obtain fits with an average of 80 to 100 volts passing 0·1 sec. This short time limit is recommended by Cerletti because animals can stand extremely high voltage but are endangered after a very long time of current passage by the long tetanic state of the respiratory muscles.

It was due to those technical precautions that the method could prove its harmlessness and might therefore become a progress in modern shock therapy.

Dr. DONALD BLAIR : During the early days of cardiazol and insulin therapy I noted similar phenomena to these described by Dr. Fleming, and published a paper on the subject in the *Journal of Mental Science*, September 1938. I then noted the following types of movements to occur either during the recovery phase following the fit, or if an insufficient dose to produce a fit was given :—

(1) Myoclonic twitchings.

(2) Various chewing, sucking, and munching movements of the mouth ; pouting ; grimacing ; and facial contortions.

(3) Various twistings and writhings.

(4) Psychosomatic restlessness.

(5) Some patients remained quiet apart from the actual phenomena of the convulsion.

I have been unable to correlate such occurrences with any particular mental symptoms or types of psychosis, and fail to see how Dr. Fleming is to explain the therapeutic effects of electric convulsion therapy on such lines.

I was disappointed to hear from Dr. Fleming of the two cases of fractured vertebræ in a comparatively small number of convulsions. In the early days of cardiazol therapy major complications were considered extremely rare ; such an early record of fractures in electric therapy must put one on one's guard against excessive enthusiasm.