ELECTRIC AND OTHER CONVULSIVE TREATMENTS

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Electric And Other Convulsive Treatments

Convulsive therapy was introduced by Meduna (Perlson, 1945) in Hungary in 1935. It was a strange coincidence that this event took place less than two years after the first reports on insulin coma treatment (ICT) appeared. It was based on the belief that schizophrenia and epilepsy do not occur together and, thus, may be antagonistic to each other. It was, furthermore, based on old clinical observations that psychotic syndromes may temporarily disappear after spontaneous convulsions. The same considerations which led Meduna to the induction of actual convulsions had led another Hungarian, Nyiro (1937), to attempts at treating schizophrenia with blood from epileptics. There are some references in the older literature concerning the beneficial use of convulsions in mental patients. Convulsions in the previously discovered insulin coma treatment had originally been considered as dangerous, and, therefore, had not contributed to the discovery of convulsive treatment. The theoretical basis of convulsive therapy became doubtful when later studies questioned the antagonism between schizophrenia and epilepsy, and even more so when it was noticed, several years after the introduction of convulsive therapy, that its best results were not obtained in schizophrenia but in depressions.

Meduna (1938) used a pharmacological means to induce convulsions. In 1938 Cerletti and Bini, in Italy, replaced pharmacological convulsive

treatment with electrically induced convulsions, whereby they introduced the most widely applied shock treatment in psychiatry. In 1957 Krantz, an American pharmacologist, and his co-workers (Kurland, 1959), as clinicians, introduced an inhalant, Indoklon, which produces convulsions.

The common feature of these three discoveries is that their inventors did not see the essential feature of their method in the chemical or physical properties of the convulsant used, but in the convulsion itself. This important fact should be remembered even if slight differences in various drugs or various types of current were occasionally claimed.

Techniques

Pharmacological Convulsive Therapy

Meduna (1938) first produced convulsions with intramuscular injection of 25 percent camphor in oil. Convulsions could be obtained with 10-40 cc. (2.5-10 cc. of camphor), according to the convulsive threshold of the individual. Camphor proved to be unreliable, because frequently the desired convulsion did not occur at all, or it happened as late as one or two hours after the injection. There also could be several convulsions. Camphor in oil was, therefore, replaced by a soluble synthetic camphor preparation, pentamethylenetetrazol, known in original European publications as

Cardiazol, and in the United States as Metrazol. Metrazol is injected intravenously in a 10 percent aqueus solution. The relatively large amount of fluid injected is a necessary inconvenience, because more concentrated solutions easily coagulate the vein at the site of injection. Quick injection is necessary to obtain a convulsion with the minimum amount, and poor veins are one of the difficulties in this type of convulsive treatment.

Metrazol treatment is usually started with an initial intravenous injection of 5 cc. (0.5 g.). If no convulsion ensues within one or two minutes, subsequent injections can be given. Other convulsive drugs have been recommended, among them picrotoxin and triazol 156 or azoman (cyclohexyl ethyl triazol). These are less reliable in the provocation of convulsions and are more slowly eliminated. Therefore, Metrazol proved to be the best convulsive drug.

A pharmacologically induced convulsion differs from a spontaneous as well as from an electrically induced convulsion by some clonic movements preceding the tonic phase of the convulsion. It has this so-called "first-clonic phase" in common with the convulsion induced by means of the inhalant Indoklon. During the initial irregular clonic movements, the patient becomes pale and frequently coughs. He then loses consciousness and presents a tonic contraction of all muscles. This tonic phase, which lasts an average of ten seconds, goes over into a clonic phase lasting thirty to forty-five seconds.

Irregular clonic movements can still occur after the convulsion is over and are peculiar to the pharmacologically induced convulsion as is the first clonic phase. Neither of these phenomena occur in electrically induced convulsions. They are probably due to a direct cortical stimulation by the drug. Occasional second convulsions occur with Metrazol, as well as in convulsions induced by inhalation but apparently never in electrically induced convulsions.

Inhalation Convulsive Treatment

Pharmacological convulsive therapy, largely replaced by electric convulsive therapy, received a revival through the introduction of convulsions with an inhalant drug, Indoklon (hexafluorodiethyl ether). The discovery of Indoklon stemmed from studies on the anesthetic action of aliphatic fluorinated ethers. One of these was found to have a convulsive action upon inhalation in laboratory animals. It was recommended by Krantz et al. (1957) under the name of Indoklon, for the treatment of psychiatric patients in whom convulsive therapy was indicated. Indoklon is a colorless, mobile liquid which is readily volatile and has a mild, pleasant odor similar to ether. It is noninflammable. In the first clinical trials inhalers, similar to those used for nasal inhalation, were used. Later, a Stephenson mask, modified appropriately with an activated charcoal exhalant absorber, was used. The mask is close-fitted with one-way flow, with the drug dispersed in a measured amount over absorbent gauze contained in a plastic reservoir with air inlets.

This is fastened into the inlet valve of the mask.

Today Indoklon is given with the anesthesia technique which will be described later for electric convulsive treatment. When the patient is sufficiently relaxed, 0.25-0.5 cc. of Indoklon are injected into the vaporizer through a rubber diaphragm, and the Indoklon is forced into the lungs by repeatedly squeezing the bag. Some myoclonic movements appear soon, but Indoklon has to be administered until sustained plantar flexion indicates the tonic phase. Only then is the mask taken off, the Indoklon blown out, and oxygen supply resumed. It is a frequent mistake that the myoclonic movements are taken for a convulsive seizure which actually starts only when the tonic phase sets in. If this is not the case, the application remains therapeutically ineffective.

There is no doubt that Indoklon inhalation treatment is equally effective as ECT. Its superiority in treatment-resistant schizophrenics has been claimed but not proven. A technical advantage is that it protects loose teeth better because the direct stimulation of the jaw muscles by the electrodes is eliminated. Indoklon did not fulfill the hope that the absence of electric application may reduce posttreatment confusion. Furthermore, it produces more nausea, and requires routine medication with Compazine in most patients. All this explains why Indoklon has not replaced ECT, although it is useful to have an alternative to ECT in patients who are afraid of a treatment

with the name "electric shock."

Electric Convulsive Treatment, ECT

The standard technique by Cerletti and Bini (1938) is still extensively used, although different types of current have been recommended. The original technique uses alternating current from the electric-light circuit at a frequency of 50 or 60 cycles. The voltage applied varies between 70 and 150 V. applied for 0.1 to 1 second. There is no need for measurement of the resistance, because the resistance of the skin changes considerably. Stimuli of less than 50-70 volts do not produce unconsciousness, cause a painful sensation, and should be avoided. Stimuli of 70 or 80 V. may produce unconsciousness but not lead to a convulsion.

They are then called subconvulsive stimuli. Increasing the current further, one may obtain a delayed convulsion. The current that produces an immediate generalized seizure varies considerably, according to the convulsive threshold of the individual patient. In general, it can be stated that young people have a lower convulsive threshold than older ones, and that women have a slightly higher threshold than men. Some machines permit the setting of the actual milliamperage which flows through the patient's head. This and other devices are controversial, however, because their reliability is questioned, and they are unnecessary, as the electric stimulus must be

sufficient to produce a convulsion. It will be shown later that there is no harm in applying too large an amount of current, and, therefore, hesitancy on the part of the therapist in giving an adequate stimulus only results in the failure to elicit the proper response.

The current is applied through electrodes placed on both temples. The electrodes originally used consisted of a meshwork mounted on a rubber sponge which, by means of a forceps, permits strong pressure and the best possible adaptation to the patient's head. Other electrodes, such as simple metal disks, can be attached with rubber bands to the patient's head, but they slip off more easily and are more apt to produce burns on the patient's skin. Permeability of the skin can be improved by an electrojelly, as used in electrocardiography, or by a saline solution.

Therapeutic efficacy does not depend on the choice of any particular type of machine. Some machines try to avoid the immediate flow of the entire current for which the machine is set and, rather, step it up slowly to the maximum (glissando technique). Other machines do not measure the time but only provide a button which is pressed until the patient goes into the convulsion. The techniques of stepping up the current more slowly were based on the assumption that the occurrence of fractures in electrically induced convulsions and their absence in epileptics is explained by the sudden onset of most electric convulsions.

Great efforts have been made to avoid memory impairment, by using different types of current. The first modifications were recommended by Friedman (1949) and Wilcox (1947), who both used a unidirectional wave form eliminating the alternating oscillations of the current. It was claimed that such half-waves rectified the 60-cycle current and produced a convulsion with lesser intensity, but workers who used this and other newer types of current usually applied the current for a longer period of time than did Cerletti and Bini with their standard technique. Therefore a comparison can hardly be made. The same is true for the brief-stimuli technique by Liberson (1945), who used stimuli lasting from 1/6 to 1/3 millisecond. Some manufacturers use a combination of unidirectional and brief-stimuli currents. Therapeutic superiority by any of these currents has never been proved. There is some evidence that the temporary memory impairment of the treatment is diminished by smaller amounts of current used with these modified techniques.

The so-called "electronarcosis treatment" was recommended by several workers from California, who used alternating current and maintained the convulsive stimulus for thirty seconds, thereby suppressing the development of clonic movements. After thirty seconds the current was reduced. At this point some clonic movements still appeared, which shows that they had been only suppressed by the continued stimulation of the brain. There is no proof that this treatment prevents any of the complications or side effects. It has

been claimed, though, that its results in paranoid schizophrenia are better than those of simple electric convulsive treatment and come closer to results obtained with insulin coma treatment. Epstein (1956) recommended unipolar electrocerebral stimulation with one electrode on the head and one indifferent electrode on the forearm, using spiked unidirectional current. Others tried focal stimulation producing unilateral seizures by applying both electrodes to one side of the head. This is contrary to the experience of most clinicians who consider unilateral convulsions, which sometimes occur in regular ECT, as therapeutically ineffective, and who repeat the stimulation if such a unilateral convulsion occurs.

A true electronarcosis or electric sleep is not obtained with any of these techniques. In 1902, the French physiologist Leduc (1902) described electric sleep induced by applying general anesthesia by means of a unidirectional pulsating current of high frequency. Similar electronarcosis without convulsion has been reported by some Russian investigators. The closest approximation to such electric sleep treatment can be seen in methods of nonconvulsive electro stimulatory treatment.

Attempts to treat mental patients with electricity without producing a convulsion were made long ago. Shortly before the introduction of ECT, Berkwitz (1939), in this country, recommended a "faradic shock treatment" for functional psychoses. The complications which occurred in electrically

induced convulsions were the reason that, soon after the introduction of ECT, attempts were made to avoid the convulsion. The so-called "subconvulsive petit-mal response" was used in a series of our patients, however, without therapeutic results. Later, several workers used even smaller amounts of current than we did, and, since the patient would have felt such low currents, intravenous injections with pentothal sodium preceded these stimulations. Improvements were claimed mostly in neurotic conditions, but not in those conditions which respond to ECT, such as depressions. Hirschfeld (1953), like many others, used special currents such as the spiked unidirectional current of the Reiter machine, but later achieved the same effect with other machines. Stimulation of the diencephalon by special placing of the electrodes above the ear and nasal electrodes as discussed by Breitner (1957), were also tried with these nonconvulsive stimulations. Another nonconvulsive application, used primarily to relieve anxiety, goes under the name of Sedac and is given for half an hour to neurotic patients.

Unilateral ECT with application of the electrodes over the nondominant hemisphere was first used by Thenon (1956) in Argentina, and then by Lancaster et al. (1958) in Great Britain. It leads to a generalized bilateral seizure which can be hardly distinguished from a seizure due to bilateral stimulation. There is definite agreement that this method avoids the usual posttreatment confusion and forgetfulness. There is, however, disagreement about the therapeutic effectiveness of the unilateral approach. While the

studies of the original workers (1958) claim identical therapeutic efficacy (Abrams and de Vito in a first paper [1969] came to a similar conclusion), Abrams in his later work (1972) found that more treatments are necessary with unilateral than with bilateral ECT in order to achieve identical results. He later recommended multiple treatments with unilateral application in the same session. Some clinicians reported the occasional need of subsequent bilateral ECT which means that the patient who did not recover under unilateral ECT would have done so with bilateral application even if no unilateral treatments had preceded them. The same conclusions were drawn in studies by Strain et al (1968). Interesting work by Abrams et al. (1972) showed differences in the EEG changes in the sense that unilateral ECT slow waves were more pronounced over the sides of treatment electrode placement, whereas the slowing of bilateral ECT was mostly seen on the left (i.e., on the dominant hemisphere).

At the present time, the conclusion must be drawn that while the unpleasant memory impairment by ECT can be avoided with unilateral ECT, the therapeutic effect is inferior.

Another modification of the treatment which helped to reduce the memory impairment seems to be what Blachly and Gowing (1966) described, in 1966, as multiple-monitored ECT. Whether or not the treatment is monitored, multiple treatments are given in the same session. They, as well as

Strain and Bidder (1970), found that after two sessions with eight to ten convulsions recovery of a depression sets in with memory impairment less pronounced than when that many treatments were given in the usual three-times-a-week routine.

Preparation of the patient for ECT consists in a general medical check-up. It will be shown later that very few, if any, contraindications exist for ECT, but there might be reasons to modify anesthesia techniques in patients with cardiac or pulmonary conditions. Medico-legal considerations are also a frequent reason for physical investigation taken prior to ECT.

The preparation of the patient for each individual treatment consists in limiting his food intake. If treatment is given in the morning, no food and no medication should be taken. If treatment is given later in the day, a light breakfast of coffee or tea, and one slice of toast four hours before the treatment should not be exceeded. More food could easily lead to nausea and vomiting. The latter is especially dangerous if treatment is given under anesthesia, which abolishes the gag reflex and permits flow of gastric material into the lungs. The bladder should be voided. Dentures should be removed, although, in patients with only a few irregularly spaced teeth, it may be safer to leave the denture in to protect these teeth. Sedation does not have to be withheld except for some drugs with hypotensive effect, such as neuroleptics. It is true that some workers combine these drugs with ECT without untoward

results, but some reports on unexplained fatal accidents seem to suggest the potential danger of such a combination. Although no such instances are known in connection with antidepressants, the hypotensive effect of these drugs also suggests caution. It became customary to withhold such medication on the morning of a treatment. In particular, these drugs should not be used by injection in acutely disturbed patients before the treatment; here barbiturates are preferable. If a patient is under Rauwolfia drugs, it is advisable to postpone treatment for a week, although this is sometimes not possible for psychiatric reasons.

The treatment is usually given to the patient while he is lying on a table in the most relaxed and comfortable position. A mouth gag is used for the prevention of tongue bite and for the protection of the teeth. A looplike mouth gag is the best safeguard against pressure on the valuable front teeth. However, a soft sponge is the most reliable means to protect all teeth in patients with a poor bite or irregular teeth.

Premedication with muscle-relaxant drugs for the prevention of fractures was first recommended by Bennett (1940) who used curare (Intocostrin). Later, curare like drugs such as tubocurarine were tried. Curare and the other drugs paralyze the muscles, owing to their action on the neuromuscular junction. Prostigmin can be used as an antidote after the convulsion to shorten the effect of the curare. In spite of this antidote,

fatalities with all of the curare preparations were frequent, and cases became known in which the patient died before the electroshock had been given. Therefore curare as well as the other drugs were abandoned.

In 1952 succinylcholine, discovered by the Nobel Prize winner Bovet, was introduced (Arnold, 1951; Holmberg, 1952) for the same purpose of relaxing the muscles before an electrically produced convulsion. Succinylcholine has no antidote, but it has the great advantage over curare that the effect of an injection usually does not last more than two or three minutes, which is sufficient for the duration of a convulsion. Succinylcholine produces a block by depolarization with an acetylcholine like effect. Muscular fasciculations, which may be quite painful, are the first effect, and a feeling of suffocation indicates the beginning of respiratory paralysis. It is for this reason that pentothal sodium or similar short-acting barbiturates are injected before the injection of succinylcholine. Our technique (Kalinowsky, 1969), developed and used by the anesthesiologist S. dell'Aria, applies the drip method using a 0.2 percent solution of methohexital (Brevital) in 5 percent dextrose solution after insertion of an 18-gauge thin-wall needle Approximately 40 or 50 mg. of Brevital induces sleep. Then the Brevital drip is followed by infusion of 0.2 percent succinylcholine chloride in 5 percent dextrose solution. While the patient is oxygenated, muscle fasciculations set in, followed by complete relaxation of the muscles. A good sign that paralysis has set in is the disappearance of knee and other reflexes. It is at this point

that the convulsive stimulus should be given.

Succinylcholine appears to be less dangerous than the preceding barbiturate anesthesia. This is suggested by clinical experience since the introduction of anesthesia in ECT, as well as by some cardiovascular complications in

ECT, when pentothal sodium was used prior to the advent of muscle relaxants. Therefore, Impastato (1956) devised a technique of giving the patient succinylcholine, followed by an immediate subconvulsive stimulus to prevent the feeling of suffocation. The subconvulsive stimulus is followed, after complete muscle relaxation, by the convulsive stimulus. This technique shows two disadvantages, namely, that the subconvulsive stimulus may be either too weak so that the patient feels the current, or too strong so that an immediate convulsion takes place before the patient is relaxed. Therefore, this technique is reserved for patients with myocardial damage or pulmonary diseases such as asthma or emphysema, where barbiturate anesthesia might be dangerous.

Constant oxygenation before, during and after the convulsion is necessary. The possibility of prolonged apnea, possible cardiovascular disturbances, and the unexpected occurrence of vomiting with flow of gastric material into the lungs, while the gag reflex is absent, make the assistance of

an anesthetist preferable, although it is not considered obligatory. Reports on fatalities are rare, but in the author's opinion higher than in unmedicated ECT. However, prevention of the frequent bone complication with these techniques is so reliable that today premedicated ECT with muscle relaxants is generally accepted as a routine procedure.

Electric convulsive therapy is usually given three times a week. It can, however, be administered every day, and even several treatments a day are recommended by those who wanted to produce a severe organic reaction as a possible way to achieve better results. Such "regressive," "confusional," or "annihilation" treatment was first suggested for psychoneuroses but later also for other conditions. We tried this method in relapsing schizophrenics without convincing results, but we could confirm the observation of others that such intense treatment does not lead to lasting memory impairment or other damage. Glueck et al. (1957) found this procedure in which the patient's regression is brought to the point of incontinence of urine and feces, superior to ordinary ETC. Cameron and Pande (1958) used it under the term of "de-patterning" and combined it with prolonged barbiturate sleep treatment and with neuroleptics. Sargant (1972) also combines ETC with prolonged sleep and neuroleptics.

Ambulatory treatment can be given in outpatient departments of hospitals as well as in properly equipped offices. Here the patient should be

kept in the office for at least one hour. He should be treated only if he is accompanied by someone who can take him home. Furthermore, supervision at home must be requested. The patient should also be warned against driving a car while there is the possibility of organic side effects. The social importance of ambulatory treatment is undeniable, especially in cases such as depressions, where a few treatments can be expected to remove the condition, and where hospitalization may be an unnecessary hardship on the patient. He and the relatives should be warned against business activities during the time of memory impairment following ECT.

Medical observations (Kalinowsky, 1969) during an electrically induced convulsion are numerous but mostly of theoretical interest. The heart rate is usually increased during the clonic phase, whereas during the tonic phase the pulse can hardly be felt. Arrhythmias are frequent in the postconvulsive phase. Observations of the circulatory system show inconsistencies, however. There is evidence that the blood pressure does not depend on the muscular contraction but is due to central stimulation. Electrocardiographic changes are negligible, showing mostly arrhythmias of very short duration. Numerous metabolic studies have been made without clarifying the therapeutic agent of ECT. The same is true for studies of blood biochemistry and spinal-fluid studies. Endocrine changes have also been studied. Plasma steroid elevation has been reported. It was claimed that the more normal the adrenal cortex response to ECT, the better the therapeutic effect. The most important clinical

manifestations of an endocrine nature are disturbances of weight and menstruation. Patients responding well to ECT gain weight. Since the same is true for patients with spontaneous improvements, however, it can be questioned whether the ECT, as such, or the clinical improvement led to the gain in weight. Menstruation is also affected and often ceases during a long course of ECT, if it had not ceased already during the psychosis before the treatment. Amenorrhea often continues for a month or two after ECT, even in clinically improved cases. The same is true for temporary impotence during and shortly after ECT. Sleep disturbances are usually concomitant with weight disturbances and are often the first to disappear in patients successfully treated by ECT. The autonomic nervous system has been studied in various ways, but again it must be said that, aside from such signs as epinephrine increase after each convulsion, most changes can be explained equally by improvement of the mental syndrome for which the patient is being treated.

Funkenstein et al. (1950) studied the response of electroshock treated patients to epinephrine and mecholyl chloride and found differences in these responses valuable for prognostication in patients undergoing ECT. The authors described various reactions in what is commonly referred to as the Funkenstein test. Details must be studied in the authors' original work. Contradictory results limited the value of this prognostic test.

Psychiatric changes manifesting themselves during ECT are manifold, and can be explained as organic-reaction types. They are unrelated to the improvement of the underlying psychiatric condition for which the patient is treated. All patients show confusion immediately after a convulsion, and a retrograde amnesia which usually clears up in one or two hours. Patients never remember any sensations from the electric shock even if no anesthesia is given. The memory impairment becomes longer in duration after several treatments. The intellectual impairment is always accompanied by some emotional disturbances, and the patient is dull or sometimes silly. Fear develops almost invariably after a certain number of treatments, and no satisfactory explanation has been found for this fear which the patient also is unable to explain. Some people are frightened by the wakening and the ensuing difficulty in orienting themselves, and by a very characteristic feeling that everything looks either strange and unfamiliar or, to the contrary, that all strangers look familiar. Postconvulsive excitement is not infrequent and may lead to dangerous aggressiveness, which may last for fifteen to thirty minutes. Patients always have a complete amnesia for such postconvulsive excitement states. If they occur once, they usually occur after every treatment, but they can be avoided by a twenty-minute drip of Brevital. Less severe excitement can be prevented by an intravenous injection of 1-2 cc. of Diazepam (Valium) after the convulsion.

A rare organic psychotic reaction occurring during or shortly after a

series of ECT is represented by disorientation with vivid auditory and sometimes visual hallucinations, a syndrome which differs from the original psychosis for which the patient is being treated. Such symptomatic psychoses may last for several days but always clear up spontaneously. Another important observation is the activation of the patient's original psychosis. This is mostly seen in quiet, blocked, or depressed schizophrenics in whom, after the first treatment, an acute delusional and hallucinatory syndrome emerges. In these cases the underlying schizophrenic psychosis, previously unrecognized, becomes overt, leading to the statement by Halpern (1949) that ECT can serve as a diagnostic aid in schizophrenia.

Psychological investigations by Zubin (1948) and many others have shown convincingly that the most constant psychiatric side effect of ECT, i.e., memory impairment, is not permanent. Learning and retention return within a few weeks after termination of treatment. Testing of patients with more than 100 treatments by Rabin (1948), Perlson (1945), and other authors showed that no organic patterns remain. More insistent complaints of memory impairment are sometimes heard from neurotic patients who are over-concerned with all side effects of the treatment, and many complain of forgetfulness long after tests have shown a return of normal memory function. The Swedish workers Cronholm and Ottosson (1963) found that successfully treated patients had less memory difficulty than those with only limited therapeutic results.

Neurological observations contributed little to the understanding of ECT. The manifestations do not differ from those observed in other convulsions. Electroencephalographic findings are quite similar to those seen in spontaneous convulsions. After several treatments the electroencephalographic record remains abnormal, being characterized generally by slow waves which disappear within one or two months after termination of treatment. The question of brain damage has been thoroughly investigated since early papers mentioned petechial hemorrhages and other bleedings in the brain. Later, studies in animals and in humans after fatalities did not confirm such hemorrhages, nor did they reveal any cell changes in the brain. In our experimentation on monkeys treated with the same technique used in our patients, no changes were found that were not likewise present in the brains of control animals. Alexander and Löewenbach (1944) demonstrated that morphologically recognizable tissue reactions are limited to the parts of the brain which lie in the direct path of the current and are limited to vasoconstriction, not accompanied by cell changes. Most studies confirmed the absence of "brain damage" in ECT. Although the presence of memory impairment and electroencephalographic changes is undoubtedly proof of reversible organic changes in the brain, it does not express itself in any neuropathology visible with present-day methods.

Complications and Contraindications

In the past, the most important complications of convulsive therapy were represented by fractures. Some difference between spontaneous convulsions in epileptics and pharmacologically, as well as electrically, induced convulsions must be considered responsible for these fractures, because they hardly ever occur in epileptics. Knowledge concerning these fractures is useful today only in order to understand why muscle relaxants are necessary. The most frequent fractures were those in the mid-dorsal spine which, however, aside from some temporary pain never led to any neurological complications because they were limited to the rigid part of the spine. Less frequent were fractures of the neck, of the humerus, and of the femur, the latter occurring only in male patients. The same was true of the rare fractures of the acetabulum.

The absence of other complications is easily understood, when we realize that epileptics never have any complications from their seizures or any aggravation of preexisting diseases.

Fatalities are extremely rare. Those few which did occur, usually concerned patients whose pretreatment examination did not indicate a particularly great risk. In most fatalities autopsies did not show any explanation for the death. In over 100,000 treatments given in one treatment unit a fatality rate of 0.003 percent was found in spite of a large percentage of old patients with cardiovascular disease (King, to be published).

The discussion of complications has shown that the contraindications established for ECT in the beginning of our experience cannot be maintained. There is general agreement that arterial hypertension does not represent a contraindication, all the more as most psychotic episodes lead to a rise in blood pressure which is reduced immediately when the patient improves under ECT. The rise of systolic pressure to 300 in one of our patients with an agitated depression, and its reduction to 160 after the first clinical improvement, shows that any attempt to lower the blood pressure as a preparation for ECT is ill-advised. Cardiovascular diseases had been considered as a complication until more and more such patients had to be treated because their mental condition and their agitation endangered the cardiovascular system. There is now an almost general agreement that such cases stand ECT extremely well, and the only precaution may consist in replacing the barbiturate anesthesia with a subconvulsive stimulus as described above. Recent coronary thrombosis is a great problem, when ECT is indicated. Variable waiting periods have been postulated (Impastato, 1956), but where treatment had to be given for psychiatric reasons as early as a few weeks after a coronary infarction, it was tolerated surprisingly well. Patients have been treated after previous heart surgery, and those with a pacemaker do not even show the normally observed asystole or arrhythmia during the treatment.

Aneurysms, especially of the aorta, tolerated even un-pre-medicated

ECT very well, as demonstrated by Wolford (1957) with a patient who received 275 ECT over a five-year period in spite of a large aneurysm which finally ruptured in a treatment-free interval. Patients with the history of an arachnoid hemorrhage or bleeding ulcers can be treated with muscle relaxant drugs without hesitation.

Pulmonary tuberculosis is no contraindication. This was important because of the frequent simultaneous occurrence of tuberculosis and schizophrenia. Fever in itself is no contraindication as seen in those severe cases of pernicious catatonia in which ECT is life-saving. Eye complications are not considered a contraindication since it was found that a convulsion does not increase but rather decreases intraocular pressure. Glaucomas are more a contraindication for antidepressant drugs than for ECT. However, the use of succinylcholine suggests eserine or other eye drops prior to the treatment.

Pregnancy is definitely no contraindication which is again in accordance with the known fact that pregnant epileptic women are not threatened by abortion or premature birth. Even in patients treated at termination of pregnancy convulsions do not produce labor pain or rupture of the membrane. Followups also did not show any damage to the child.

Age is no contraindication as has been amply demonstrated in patients

treated at the age of over eighty. Children have been treated without harm as shown by the extensive experience of Bender (1947).

Bone diseases, even recent fractures, are no contraindication if muscle relaxants are given in adequate dosage. Arthritis of the spine, spinal curvature, and even recent laminectomies do not represent contra-indications as was shown by such cases even before muscle relaxants were available.

Indications and Results

Pharmacological convulsive therapy and its later modification of electrically induced convulsions were introduced for the treatment of schizophrenia. However, a few years later, it was recognized that the most spectacular results were obtained in the treatment of the affective psychoses, and here mainly in depressions. Insulin coma treatment, which had also been introduced for the treatment of schizophrenia, remains limited to this disease. The indications for convulsive therapy and its most widely used technique of electric convulsive therapy include both affective disorders and schizophrenic psychoses, as well as a number of other psychiatric disorders. There are many statistical evaluations of results. They are so numerous that their individual listing would go beyond the scope of this contribution, but they can be found in a monograph on the subject (Kalinowsky, 1969).

Depression and Manic States

The most favorable results in ECT are undoubtedly obtained in depressions. Some statistics for ECT in typical psychotic depressions come close to 100 percent recoveries of the episode for which the patient was treated, although future episodes of depression cannot be prevented. The patients usually respond after two or three treatments, but it is necessary to give a few more to stabilize the improvement. However, it is hardly ever necessary to give more than six to eight treatments in depressions. The first three treatments should be applied within a week, whereas the subsequent ones may be spread over longer intervals. They may be spaced more closely in cases of serious suicidal danger. Depressions respond equally well whether they are manic- depressive, involutional, or those of old age.

Today the most important decision for the psychiatrist is whether to treat a depression with pharmacotherapy or with ECT. Most patients referred to a specialist are already under antidepressant medication, although often in inadequate amounts. An attempt with increased dosage is usually the first step if there are no reasons to institute ECT immediately. The overriding consideration is suicidal danger which is present in every psychotic depression. There are no reliable ways to estimate suicidal danger. It is true that patients of the older age group are statistically more apt to commit suicide in a depression. However, all of us have misjudged this danger, and

such accidents are the reason why ECT in depressions is again more widely used. Other considerations are time and money. The lack of job protection and the limited period of insurance for psychiatric hospitalization often rule out time-consuming use of drugs. There is ample proof that ECT remains the most reliable treatment for endogenous depressions.

Combination of ECT and antidepressant drugs is of little value. If pharmacotherapy has failed, its combination with ECT has no advantage and the hypotensive effect of antidepressants might be potentially dangerous for the barbiturate anesthesia during ECT.

In neurotic or reactive depressions ECT has less convincing results. However, if the depressive affect in a neurotic patient is very deep and neither psychotherapy nor antidepressant drugs were successful, ECT should be tried. Side effects, such as complaints of memory impairment, are more frequent in this group of patients.

Depressive episodes occurring in manic-depressives cannot be prevented by treatment of the individual episode. Prophylactic ECT as demonstrated by Geoghegan and Stevenson (1949) is useful in patients who have very frequent episodes. It could be shown convincingly that in such cases one ECT in monthly intervals prevents future episodes. Today antidepressant drugs can be tried for the prevention of future episodes. More

promising is lithium carbonate in patients with bipolar depressions. In monopolar depressions results with prophylactic lithium are less convincing, and monthly ECT is still indicated if the depressions are frequent enough to warrant it.

Toward the end of a depressive episode, patients sometimes show a slight hypomanic state which usually clears up within one or two weeks. The same has been observed in spontaneous remissions. There are also patients whose depression is immediately followed by a true manic phase of the disease.

The manic phase of a manic-depressive psychosis also responds to ECT. Treatments are successful only if they are given close together, one or two treatments a day. This often leads to the remission of a manic phase with the same number of treatments as in depressions (six to eight). Sometimes longer series of treatments are necessary in manics. It should be realized that manic syndromes are often unrecognized schizophrenic syndromes and are less responsive to a short series of ECT. The indication for ECT in manic patients has changed since the introduction of lithium carbonate. This type of medication is certainly superior to ECT in milder manic episodes. In severe manic excitement, ECT is still useful in removing the acute symptomatology within a few days until simultaneously started lithium carbonate becomes effective and is then continued as long-term medication.

Involutional melancholia also clears up spontaneously, but the duration of the illness is usually much longer than in depressive episodes of manic-depressive patients. Therefore, these patients should be subjected to ECT as soon as possible. Fortunately, even a longer duration of illness does not interfere with a favorable outcome. Results are equally as good in retarded as in agitated depressions, a statement which is also valid for manic-depressive and senile depressions. Failures are usually due to schizophrenic and paranoid symptoms of an involutional psychosis, a group which actually belongs to the schizophrenic psychoses.

Depressions of old age respond equally well to convulsive therapy. The importance of this cannot be overemphasized, because patients in this age group, when they become psychotic, are usually diagnosed as senile psychoses, and such cases are considered organic reactions to an irreversible brain condition. Careful diagnostic appraisal of all old-age patients reveals that many of them do not show the typical intellectual impairment of senile or presenile psychoses but the symptomatology of a retarded or agitated depression which could have likewise occurred at an earlier age. Sometimes more careful anamnestic searching will reveal that such patients did have depressions at an earlier age. These persons stand ECT very well, and clinical experience shows that they recover with a smaller number of convulsive treatments than do many cases of depression in the younger age groups.

Schizophrenia

In the group of schizophrenics, results with ECT are far less spectacular than in the affective disorders. Patients with acute symptomatology may also become symptom-free after the same number of treatments (three or four) that clear up a depression. After such few treatments, however, schizophrenics invariably relapse. Therefore, many workers have requested that in pharmacological and electric convulsive treatment a minimum of fifteen or more convulsions be given even in patients who appear symptom-free after a few treatments.

Pharmacotherapy with neuroleptics has changed the indications for ECT in schizophrenics. This is particularly true in chronic schizophrenics for whom ECT never had much to offer. The symptomatic improvement of disturbed behavior is today almost entirely the domain of neuroleptic drugs. There are, however, still some indications for ECT in chronic schizophrenics. One example are those patients whose illness runs in episodes and who are known to respond to a very few treatments. A second group are those who show some irreversible changes in the sense of Bleuler's primary symptoms but who, in spite of neuroleptic medication, have acute exacerbations with psychomotor excitement, paranoid or other symptoms which respond to ECT. A third group are chronic schizophrenics with symptoms that do not respond well to drugs, such as catatonic stupor. If these patients begin to slow down

and withdraw, a few ECT's or an occasional maintenance treatment can keep them functioning. Finally, there is a considerable number of chronic patients who do not take their medication, either because of negligence or because of subjective side effects. Here ECT in an ambulatory setting can be of great value.

Acute schizophrenia continues to be an important indication for ECT. In these patients the indications for ECT and neuroleptic drugs overlap. If an acute catatonic excitement responds to pharmacotherapy, there is no reason to give ECT. However, often the symptoms are only covered up by the medication. Therefore, these acute patients who have a good chance for a full and lasting remission, should be withdrawn tentatively from neuroleptic medication before they are discharged from the hospital. If they then relapse into their previous symptomatology, ECT instead of drugs should be instituted in the hope that the patient achieves a full remission and can be discharged without medication. One reason for this recommendation is that these acute schizophrenics should be given the opportunity of a treatment which is most effective during the first year of illness but may lose efficacy later. If chronicity cannot be prevented, continued pharmacotherapy can still be of great symptomatic value after years of illness.

The various subtypes of schizophrenia respond differently to convulsive therapy. It has often been said that catatonic stupors respond best. This is

true from a symptomatic standpoint because even chronic catatonics respond well to two or three treatments. The results, though, are not lasting, and these patients tend to relapse. Catatonic excitement and acute paranoid states respond best to ECT. In catatonic excitements the treatment is often life-saving and should be instituted immediately even in patients with dehydration and high fever. Three treatments, given within twenty-four hours, remove the threatening condition. Here, neuroleptic drugs are often contraindicated in the required large amounts, particularly when the disturbed behavior makes injection of the drug necessary. The hypotensive effect of neuroleptics may lead to vasomotor collapse, a complication which may even occur spontaneously in these patients, who, therefore, were described as having "pernicious catatonia." Here, ECT has its best results and is well tolerated even if these patients are in extremely poor physical condition.

Chronic paranoid schizophrenia with insidious onset in the middle-aged patient respond less well and usually require a long series of treatments. Hebephrenics and the simple type of schizophrenia show the poorest results. This confirms the often repeated fact that the primary symptoms of schizophrenia do not respond in a convincing way to any of our treatments, and that the secondary symptoms are the ones that are amenable to treatment. It also makes it understandable that even schizophrenics in remission frequently show some "scarring" in the sense of loss of emotional

responsiveness or other primary symptoms of schizophrenia. The pseudoneurotic type of schizophrenia also responds poorly to ECT, except if complicated by acute panic states or depressive features which clear up after a few treatments but leave the basic illness untouched.

Postpartum psychoses are usually schizophrenic episodes occurring after childbirth. Depressive features are frequently in the foreground and may explain the favorable prognosis of many of these cases. There are, however, some postpartum psychoses which are particularly resistant to shock therapy. On the whole, the response of these patients to ECT does not differ much from the results in other schizophrenic patients.

Other Indications for ECT

Other indications for convulsive therapy are rare or unsatisfactory. The most important fact is that ECT has hardly any indications in the large group of the neuroses. Much of the objection to ECT stems from its indiscriminate use in this type of patient. Anxiety, the most frequent symptom in neuroses, is often aggravated by such side effects of ECT as memory impairment and a feeling of unreality. Cases of conversion hysteria frequently add the side effects to the already-existing symptoms. Psychosomatic symptoms occasionally benefit from the blurring effect of ECT. This is particularly true when psychosomatic symptoms occur episodically with some degree of

depressive mood, a group of patients which today is often described as "masked depression," and which Foster Kennedy (1944) labeled as "manic-depressive equivalent." In most neurotic and psychosomatic conditions ECT has nothing to offer, and it should be added that attempts to use it as an adjunct to psychotherapy in the sense of making patients more accessible, are bound to fail. A notable exception are psychoneurotic or reactive depressions, which may respond well to a few convulsive treatments. This supports the view held by many that depressions in such patients are actually unrelated to the neurosis, and it is seen again and again that such a patient's depression clears up, but that his neurotic symptoms persist. The fact that obsessive-compulsive neuroses and anxiety neuroses do not respond to ECT in any lasting way is in accordance with the experience that such symptoms in depressions or in schizophrenia tend to mar even an otherwise favorable prognosis for ECT. Some claims have been made for favorable results in psychoneurotics who had been treated with the intense method of regressive shock. Nonconvulsive electrostimulation treatment was found to be more valuable in psychoneurotics, but the simultaneous use of barbiturate anesthesia in nonconvulsive treatment may account for these results.

Organic psychiatric disorders offer some indications for symptomatic ECT. They have, however, been mostly replaced by the newer drugs. The most frequent, although purely symptomatic, use of ECT is made in the organic psychoses of old age. In these patients such disturbing symptoms as agitation,

depression, and paranoid delusions can often be removed with a few ECT's which are often better tolerated by very old patients than psychotropic drugs in large doses. In mental deficiency, epilepsy, and other organic conditions, disturbed behavior can be influenced by ECT. In general paresis, depressive, manic, and paranoid syndromes can be removed symptomatically by ECT, but the basic treatment of the underlying pathology is penicillin or malaria. The practical value of ECT in general paresis is that it quickly removes symptoms which often make the treatment of these patients in neurological wards so difficult. In Parkinson's disease the non-infrequent depressions or paranoid episodes respond very well to ECT, and the neurological impairment in these and other patients with neurological ailments often improves remarkably after the removal of the emotional disorder. In epileptics, ECT has some interesting indications: clouded states, which usually clear up after spontaneous convulsions, can be equally shortened by two or three electrically induced seizures. The rise of the convulsive threshold, which is observed after each convulsive treatment, also led to attempts to decrease the number of spontaneous convulsions in epileptics. The practical importance of such attempts, even though successful, is minimal. In some neurological conditions such as hyperkinetic manifestations, results have been contradictory. A few psychosomatic disorders may respond to ECT. Favorable results have been reported in neurodermatitis, bronchial asthma, and other conditions. Intractable pain of various kind, including trifacial neuralgia and

pain of phantom limbs, may respond well, though certainly not in any predictable way. A last indication to be mentioned is the possibility of preventing withdrawal symptoms in drug addiction. This method has been quite successful in the treatment of morphine and barbiturate addiction in open hospitals. But it has lost importance since the introduction of the new drugs. The same is true for toxic and postinfectious psychoses, where ECT was successful but is today replaced by drugs.

The clinician will make occasional use of ECT in various conditions (Gallinek, 1952), but it should be repeated once more that the actual indications lie in the field of the major psychoses.

General Remarks

Although the place of ECT in the therapeutic armamentarium of the psychiatrist is definitely established for the treatment of psychotic patients, there are those who feel that any disease expressing itself in psychological symptoms can be treated only by psychological means and that convulsive therapy is only an adjunct to psychotherapy. That this is not the case is clearly proved by the excellent results of ECT in depressions, and particularly in involutional melancholia, for which most patients are treated without psychotherapy. The question as to what extent future depressive episodes can be prevented with psychotherapy after ECT is an open one. Again,

another problem is the use of ECT to improve the patient's accessibility to psychotherapy. This has been tried, especially in neuroses, with one or a few ECTs but results remained unconvincing.

My own experience includes two parallel series of patients, one treated in a large institution without psychotherapy, and the second in a teaching institute with intensive psychotherapy for each patient. The comparative results did not support the view that psychotherapy is indispensable to obtain favorable results with ECT. This, of course, does not contradict the advantage of proper supportive psychotherapy in any patient treated for a psychological disturbance. It should also be emphasized that, in hospital patients, occupational and work therapy as well as a progressive hospital management are important factors contributing to good results in the rehabilitation of patients.

Discussions of the theoretical aspects of convulsive treatment largely reflect the concepts of different authors. Gordon (1948) was able to publish fifty different theories on ECT. They can be classified as partly psychodynamic and partly somatic. The shock therapies represent a somatic approach to the treatment of psychological disease, and, therefore, a somatic explanation of their mode of action seems to be more probable than a psychological one. Yet psychological theories have been advanced in considerable number. Whereas in insulin coma treatment the more intimate contact with physicians and

nurses has been considered as psychotherapeutically valuable, ECT, with its post-treatment amnesia, does not offer itself to such theories. The concept of the "psychic shock" caused by any treatment that makes the patient unconscious, has been promoted, however, by a number of authors. In Metrazol treatment, the sensation of deathly fear before the convulsion was considered an important psychotherapeutic factor. This concept, however, had to be abandoned when this sensation was eliminated in the electrically induced method. The experience of coming close to death, though, followed by the feeling of rebirth, was common to all shock treatments and was thought to break the patient's autism and to counteract his regression and narcissism. It has also been claimed that the threat of death helps to mobilize the patient's vital instincts.

The especially good results in depressions with guilt feelings led to the theory that the treatment works because it represents a well- deserved punishment for the patient's sins. Experience with many depressed patients suggests, however, that most of them do not consider this treatment as a punishment; even if one assumes that they do consider it as such, there are many valid objections against such explanations of the therapeutic effect of ECT.

It appears that all psychological theories connected with the frightening experience of the treatment could not explain the uniformity of results, for

instance in depressions, because many patients do not have any fear, or they develop fear only after they are improved. It should also be borne in mind that ECT remains unsuccessful if the patient is treated only with stimuli which render him unconscious but do not produce convulsions. The ineffectiveness of nonconvulsive treatment in conditions where the convulsion proves to be beneficial is the most convincing evidence against any psychological theory, because the patient's psychological experience is the same, whether or not he convulses during his state of unconsciousness. It may also be added that barbiturate anesthesia without electric convulsion, and nitrogen anesthesia, to mention another therapeutic attempt, do not have the same results. Another point to be made against purely psychological theories is the fact that psychoneurotics for whom the experience of the treatment has the greatest psychological impact show the poorest results. A combination of psychogenic and organic concepts was tried by Schilder (1939), who stated that the victory over the death threat in any epileptic seizure and the perceptual and aphasic difficulties of the postconvulsive state enable the patient to start life and normal relations all over again. He emphasizes, however, that, although the results of the treatment can be psychologically understood, this does not mean that it acts primarily as a psychological agent in the common sense. The same should be said about some psychoanalytical theories of shock treatments, which are interesting attempts to describe the phenomena during shock treatments in analytical terms but hardly explain satisfactorily why a

convulsion rather than simple unconsciousness is necessary for therapeutic results.

Unfortunately, somatic theories of convulsive therapy are also far from being satisfactory. There is actually not one somatic theory that could not be easily disproved. It has been stated already that the theory of the antagonism between schizophrenia and epilepsy, which led to the discovery of convulsive therapy, could not be maintained. The assumption that a convulsion eliminates toxic substances from the nerve cell was suggested in convulsive treatment by the old concept that an epileptic seizure has the purpose of eliminating toxic substances.

Attempts to localize the effect of convulsive therapy concentrated on the diencephalic centers. Stimulation of the diencephalon locally rather than with a generalized convulsion was tried. The importance of the diencephalic region for the effect of ECT is supported by symptoms such as weight gain, improved sleep, menstrual changes, and other manifestations. Such concepts logically follow ideas on the origin of psychiatric syndromes in the diencephalon. The influence of ECT on the vegetative centers of the brain also played an important part in the theoretical concepts of some French authors (Delay, 1946) who devoted monographs to the subject. Theories of reduced oxygenation as a therapeutic agent became obsolete after the introduction of anesthetic techniques in ECT. Oxygenation before and after the convulsion in

patients premedicated with succinylcholine rather tends to over-oxygenate patients under ECT. Work on changes of the vegetative nervous system did not lead to more convincing theories than did many of the other laborious studies on the biochemistry of convulsive treatment. Attempts to explain the therapeutic effect with organic brain changes have also been made. Although neuropathological changes are absent, the electro- encephalographic and psychological changes would support such a view. These changes, however, are still practically absent when, for example, depressions clear up after two or three treatments. The purely empirical nature of convulsive therapy cannot be denied. This is not surprising in a treatment of disorders for which no etiology is established, and it should not be a reason to withhold such treatment where clinical experience has demonstrated its usefulness.

Electroconvulsive therapy, as the most widely used form of convulsive treatment, continues to be a very effective therapeutic measure in psychiatry. This is so in spite of many misconceptions listed by Furlong (1972) in an article on "The Mythology of Electric Convulsive Therapy," in which he concluded that neither the treatment nor the myths have left us yet. The advent of pharmacotherapy raised the hope that medication would replace this and other complicated procedures. Many reports on neuroletpic drugs in schizophrenia and on antidepressant drugs claimed that the new psychotropic drugs have replaced ECT. Later, comparative studies and, more so, clinical experience demonstrated that the hope of replacing ECT was

premature. In recent years, ECT is again on the increase in spite of its frightening name, persistent theoretical objections, and its poorly understood mode of action. The number of publications on ECT is again growing, the difficulty of using anesthesia techniques for a psychiatric treatment has been overcome in many hospitals, and the public has become increasingly aware of the effectiveness of this somatic treatment in psychiatry.

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