THE ROUTINE USE OF MUSCULAR RELAXANTS PRIOR TO ELECTRICAL CONVULSIVE THERAPY.

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IT is probable that the incidence of vertebral fractures during E.C.T. is greater than was formerly thought to be the case. Meschan, Scruggs and Colhoun (1950) found vertebral compression fractures in over 35 per cent. of 212 cases treated with E.C.T. Plattner (1949), in a series of 500 cases (200 men and 300 women), found fractures in 58 (37 men and 21 women). In 20 of his cases E.C.T. had to be abandoned on account of the fracture.

Some psychiatrists may feel that vertebral fractures are not so common as these figures would suggest. The reason for this may be that many slight compression fractures do not immediately produce severe pain, and hence pass unnoticed. We fear that ultimately, perhaps after some years, unpleasant arthritic changes may develop in such patients.

Besides the strain on the skeleton, the cardio-vascular system is also subjected to stress during E.C.T. as there is an elevation of blood-pressure during the seizure. Arterio-sclerotic and hypertensive patients—now requiring treatment in increasing numbers—run a special risk on this account.

The relaxants in common use have been those of the curarizing type such as gallamine triethiodide ("Flaxedil") and d-tubocurarine chloride ("Tubarine" or "d-TC"), and those of the depolarising type such as decamethonium iodide ("Eulissin P"). The mode of action of these two groups is compared in a paper by Paton and Zaimis (1950).

Certain disadvantages of the curarizing type of relaxant are:

1. That muscular relaxation often outlasts the period for which it is required, and this may be serious where prolonged respiratory paralysis is involved.
2. That side effects occur, attributable to the release of histamine and heparin.
3. That the relaxation secured by safe dosage is not always adequate.
4. That the injection of prostigmin as a routine antidote to curare is not without danger, as it is in itself a powerful drug capable of producing undesirable side-effects.
5. That the ordinary d-tubocurarine is not miscible with thiopentone, which is usually given along with it to avoid the unpleasant subjective sensations accompanying muscular relaxation.
6. That the delay of four or five minutes with each patient while curare is taking effect means an appreciable loss of time when a number of patients are being treated.

Trials with Decamethonium Iodide.

Decamethonium iodide has a similar relaxing effect to curare, although it is dissimilar pharmacologically. This drug has now been tested clinically and favourable results have been reported from Davies and Lewis (1949), Grob, Holoday and Harvey (1950), Hobson and Prescott (1949), and Unna *et al* (1950). The principal advantages are a briefer duration of action and a relative freedom from side-effects. Recently, however, undesirable cardio-vascular and respiratory complications have been reported (Guerrier and Mason, 1952). Unlike curare, decamethonium iodide may be mixed in the same syringe with thiopentone, and it may be injected rapidly. The principal disadvantage is the absence of an effective antidote.

We have used decamethonium iodide—("Eulissin P")—in 40 cases (25 females and 15 males), ages ranging from 21 to 73. In all, 234 treatments were given. In six cases only was relaxation regarded as inadequate. In three of these cases the patients were unusually muscular and the other three were elderly. In each of these

cases, a simple adjustment of the dosage brought about satisfactory results. All but one of the 40 re-commenced respiration promptly, and with this one the difficulty was subsequently overcome by reduction of the dosage of decamethonium iodide. Oxygen was given by forced insufflation of the lungs in every case until respiration recommenced. No side-effects attributable to the drug were seen except in one elderly male who had attacks of diarrhoea following each treatment. All except three of the patients accepted treatment readily. One of these three based his fear on a previous acquaintance with curare, one was inordinately apprehensive in general, and the third was a paranoid schizophrenic.

In 14 cases blood-pressure readings were taken—

(1) immediately before the injection,
(2) just before the administration of the electrical stimulus, and
(3) just after the seizure.

In each case the second reading was lower than the initial one, the reduction being 10–40 mm. Hg for the systolic and 0–30 mm. Hg for the diastolic. In five cases there was an increase of both systolic and diastolic pressures immediately after the seizure, the systolic being raised by about 60 mm. Hg and the diastolic by about 20 mm. Hg. In the other cases the blood-pressure was simply restored to its pre-injection level.

We concluded from these results that decamethonium iodide (" Eulissin P ") was a satisfactory relaxant. We believe that the absence of an antidote is not a serious contra-indication, provided facilities are at hand to give oxygen effectively. A potential risk would seem to be irreversible C.N.S. changes due to cerebral anoxia occurring as a result of inadequate inflation of the lungs.

Preliminary Trials with "Scoline."

Experience with decamethonium iodide for routine use under nursing-home conditions encouraged us to try succinylcholine chloride (Syn. Succinoylcholine Chloride, Suxamethonium Chloride, or Succimethonium Chloride) or " Scoline " (Allen & Hanbury). This substance is an ultra-short-acting muscular relaxant of the depolarizing type. It has recently been the subject of a report by Bourne, Collier and Somers (1952). Reports of " Scoline " both in anaesthetic practice and as a relaxant for E.C.T. are favourable (Brucke *et al.*, 1951 ; Thesleff, 1951 ; Mayrhofer, 1952 ; Richards & Youngman, 1952). Recently prolonged respiratory paralysis has been reported (Harper, 1952 ; Hewer, 1952 ; Hurley and Monro, 1952 ; Grant, 1952) following " Scoline," but there seems to be no other serious complication recorded. This danger is rare, and we have not met with it in our series.

An initial trial under nursing-home conditions was carried out. Thirty-four patients (12 males and 22 females) were treated, a total of 183 treatments being given in all. These were predominantly cases of depression occurring in the involutional period. They were drawn from the upper income groups, and were probably of rather higher intelligence than the average. They were certainly exacting, and capable of formulating criticism. Many had had previous experience of unmodified E.C.T., and a few had had other relaxants previously. Almost without exception these patients expressed a preference for our technique using thiopentone and " Scoline."

Of these 34 patients, 9 were so frail, aged or physically ill that we judged them to be unfit to stand a course of unmodified E.C.T.—(these are included in Table IV). None suffered any detectable ill-effects which we could attribute to E.C.T. as modified by thiopentone and " Scoline." Observations carried out during this trial period confirmed the findings of other workers (Bourne, Collier and Somers, 1952) in general, and are not recorded in detail in this paper, with a few exceptions (*vide infra*).

The Routine Use of "Scoline."

Following preliminary trials it was decided to introduce " Scoline " as a routine premedication for all E.C.T. in the mental hospital. This method has now been used by us for six months, and our experience is summarized in Tables I and II.

In general, modified E.C.T. has been as effective therapeutically as unmodified E.C.T., though in a few cases this was apparently not the case. This apparent discrepancy is now being investigated, and we hope to make it the subject of a subsequent report.

TABLE I.—*Numbers of Patients Treated.*

	Modified E.C.T. (preliminary trials).	Modified E.C.T. (routine).	Unmodified E.C.T. (during previous 6 months).
Males	12	111	66
Females	22	199	125
Total	34	310	191

TABLE II.—*Numbers of Individual Treatments Given.*

	Modified E.C.T. (preliminary trials).	Modified E.C.T. (routine).	Unmodified E.C.T. (during previous 6 months).
Males	57	877	627
Females	126	1560	1149
Total	183	2437	1776

Susceptibility to "Scoline."

In two cases relaxation was insufficient using the recommended dosage and a substantial increase (to more than double the usual dose) was necessitated. One of these patients, a woman weighing 160 lb., eventually received 85 mgm. of Scoline with only slight modification of the seizure. The other case was a lean and muscular man, who was fairly well relaxed at exactly twice the original (recommended) dosage.

In three cases the initial dose was slightly reduced. Two of these patients were markedly wasted, an observation in keeping with the reports of Bourne, Collier and Somers (1952), who regard malnutrition as a causal factor in hyper-susceptibility to "Scoline." The serum cholinesterase was not estimated in our cases.

In every other case the dosage recommended by the manufacturers was found to be satisfactory.

Immediate Effects of "Scoline."

(*a*) Respiratory: We have not encountered the prolonged respiratory paralysis reported by other workers (Harper, 1952; Hewer, 1952; Hurley and Monro, 1952; Grant, 1952). The longest period of apnoea was five and a half minutes.

(*b*) Blood-pressure: In 25 cases the blood-pressure was recorded (1) immediately before the injection, (2) immediately before the electrical stimulus, and (3) as soon as possible after the seizure. The results were very variable. The injection was generally followed by a slight fall in pressure and the electrical stimulus by a slight rise, but no really constant pattern emerged. The readings in each case could well have been accounted for by the effects on the musculature. This is in keeping with the findings of Somers (1951) quoted by Bourne, Collier and Somers that the blood pressure of the cat is not affected with ordinary dosages.

(*c*) Fractures: During the control period ten fractures of the bodies of vertebrae are known to have occurred, and we have no guarantee that milder cases were not missed. There was at no stage any suggestion of a fracture in the patients treated by modified E.C.T. It occurs to us as a potential danger, however, that staff becoming familiar with the very mild seizure of modified E.C.T. may relax precautions to the detriment of the rare case who, through insusceptibility to "Scoline," does have a strong convulsion.

Apparent Delayed Effects of "Scoline."

Frequent detailed examinations of all patients undergoing modified E.C.T. has been impracticable. All unusual occurrences have, however, been investigated and

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recorded. The vast majority of these were certainly unrelated to " Scoline." Symptoms which may prove to be significant are summarized in Table III.

TABLE III.—*Incidence of Complaints Following E.C.T.*

Complaint.	Modified E.C.T.			E.C.T. unmodified.
	Males (1,027).	Females (1,879).	Total (2,906).	
Fractures	0	0	0	10
Muscular pains and stiffness	15	5	20	?
Headache	5	9	14	?
Dizziness	2	5	7	2
Sickness	3	9	12	3
Dyspnoea	1	5	6	1
Rash	2	3	5	0
Haematemesis	1	2	3	1

(*a*) Haematemesis: Three patients on treatment with " Scoline " suffered moderately severe haematemesis. All three cases gave a history vaguely suggestive of peptic ulceration. In one there was a history of cerebral thrombosis two years previously, and in another there was a history of coronary thrombosis one year previously. In the latter two instances we gave E.C.T. with some misgivings, and made a particular point of ensuring efficient inflation of the lungs with oxygen.

The relationship of these serious occurrences to " Scoline " and E.C.T. is not clear. At first sight a causal connection is unlikely, but taken in conjunction with the incidence of anorexia, nausea and vomiting it seems that treatment cannot be excluded as a possible precipitating cause. It may be that during inflation of the lungs with oxygen after the seizure some of the gas occasionally enters the stomach. Gastric distension produced in this way might account for the disaster in a patient predisposed for any reason.

(*b*) Sickness (including anorexia, nausea and actual vomiting): This was an occasional source of complaint, though invariably a transient phenomenon. It may have been related to gastric distension by oxygen, though actual eructation of wind was rare.

(*c*) Headache: This was certainly very much less common following modified than following unmodified E.C.T. No reliable figures are available for the control period, as post-convulsive headache was rarely recorded, though known to occur frequently.

(*d*) Muscular discomfort: This, too, was formerly very common, though rarely recorded. It was certainly much less frequent following modified E.C.T.

(*e*) Rash: A morbilliform rash occurred once after a patient's first treatment and four times after fourth or fifth treatments. It appeared about eighteen hours after treatment on each occasion and lasted from two to six hours. It is known that histamine is released in small quantities by " Scoline " (Bourne, Collier and Somers, 1952), but in none of our five subjects was there any other evidence to suggest histamine release, and the rash was never typically urticarial in appearance.

(*f*) Dizziness: This was a mild symptom, occurring during the few hours immediately following treatment. There was neither deafness nor tinnitus, and the symptom did not amount to true vertigo.

It is of interest to note that the " confusional " period immediately following E.C.T. was apparently reduced by the use of a relaxant, although we have no statistical support for this observation. Presumably, as in the normal individual, the presence of tired, aching muscles tends to discourage an early return of full consciousness. This will be of significance more particularly in out-patient work.

Absence of Contra-indications.

Of the total number (397) of patients treated by modified E.C.T. 77 had physical disabilities which would ordinarily have contra-indicated E.C.T. These are recorded in Table IV.

Apart from the three cases of haematemesis already mentioned, no complication or aggravation of an existing disability occurred.

TABLE IV.

Patients physical abnormality.	Number treated. Male.	Female.
Hypertension (over 90 diastolic)	12	23
Other cardio-vascular disease	3	6
Organic brain damage	2	5
Old age, debility, etc.	5	11
Rheumatoid arthritis	3	4
Recent surgery	1	1
Puerperium	—	1

Technique.

The choice of technique is dictated so largely by local conditions and by individual preference that a detailed description would be superfluous and presumptious. Suffice it to say that we have been able to treat an average of fifteen patients an hour without haste and without running risks.

No routine premedication is employed. We attach great importance to an empty stomach, however; vomiting (before respiration is restored) is a potential disaster.

We employ the dose of " Scoline " recommended by the manufacturers (Messrs Allen & Hanbury) and have rarely found it necessary to alter this. Thiopentone and " Scoline " mixed in the same syringe are effective if given promptly, but we prefer to use separate syringes and a single needle. This obviates occasional unpleasant sensations attributable to the effect of " Scoline " preceding unconsciousness.

In the generalized muscular twitching which appears about fifteen seconds after the injection of " Scoline " we have never seen violent movements occur. We have, however, frequently noted semi-purposive movements apparently organized at a fairly high neurological level. We attribute these to thiopentone, and regard them as the " excitement stage " of anaesthesia.

Full relaxation follows the disappearance of the mild twitching movements; an additional guide is the disappearance of the grasp reflex. Electrodes are applied and in some instances oxygen administered during the pre-relaxation phase. Following the electrical stimulus both tonic and clonic phases of the convulsion can generally be detected.

Immediately after the modified convulsion an airway is inserted and oxygen is administered through a close-fitting face-piece until a good colour returns to the skin. When respiration is satisfactorily re-established the patient is put to bed on his side. A careful watch is maintained until he is fit to walk.

No additional staff are called upon to administer this form of treatment, and from the point of view of convenience it is little inferior to unmodified E.C.T. An advantage is the use of two trolleys; while one patient is receiving oxygen the next is being prepared for the injection.

Summary and Conclusions.

The use of unmodified E.C.T. is attended by serious risks, which can be eliminated by the use of a suitable relaxant. Over a period of six months we have used " Scoline " on 2,437 occasions as part of routine treatment in a mental hospital. We find it a safe and reliable relaxant, convenient to use in conjunction with thiopentone in small doses.

We consider that unmodified E.C.T. is now out-moded.

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