improvement is maintained so long as some degree of disintegration of pattern of thought can be effected by the fits. Individual cases have often done well, particularly where a lively affective reaction accompanies schizophrenic thinking. Even so, as Sargant and Slater (1944) have pointed out, relief of the mood disorder may occur, leaving a pathological thought content uninfluenced. It is hardly surprising, therefore, that figures for large series of such patients are not to be compared with results in depressions, and in the long run are not better than those in controls. By contrast, in psychotic depression the patient may have recovered, or be well on the way to doing so, before discoverable abnormality of memory or E.E.G. can be found. Old people often respond well to E.C.T., although about the age of 60 or later it is not uncommonly found that, after dispersal of depression, senile changes remain in the form of narrowness and poverty of ideation, tendency to perseveration, and the use of a very limited range of words. In mania the effect is less dramatic, yet E.C.T. appears to exert a form of sedation on the manic symptoms, often most useful at the height of the illness. Neuroses, depressions with neurotic features, and reactive depressions have all been described as possessing characteristic reactions to convulsion therapy. It is certain that the careful observation of these reactions under in-patient conditions can give much useful information about the underlying psychopathology, duration of treatment, and prognosis—the very part of the treatment requiring a specialist's attention.

TABLE VIII.—Case Selection for E.C.T.

Favourable	Doubtful	Contraindicated
Psychotic depression with retardation, agitation, delusions, and neurotic or psychopathic complications	Schizophrenia	Anxiety neurosis
Depressed phase of manic-depressive psychoses	Paraphrenia	Hysteria
Recurrent depression	Paranoia	Neurasthenia
Involuntional depression	Obsessional neurosis	Organic psychoses with syphilis or with arteriosclerosis
Reactive depression where reactive stress has faded	Idiopathic epilepsy	Pre-senile dementia
	Post-encephalitic	Post-traumatic syndromes
	Parkinsonism	Huntington's chorea
	with depression	

Regarding the whole problem of mode of action, it is difficult to escape the conclusion that a varying degree of personality disintegration and regression is required, sufficient to disorganize the recently acquired habits of feeling and thinking. The personality then employs long-established reflexes and patterns of behaviour to readjust at a slightly lower level, but not necessarily to stay there. Concerning the far more drastic procedure of leucotomy, Golla (1943) recalled the work of Sherrington and Graham Brown demonstrating the remarkable recuperative powers of even the severely damaged nervous system. Similarly, in the few weeks immediately following convulsion therapy this inherent recovery process is paralleled by a gradual disappearance of forgetfulness and of such dysrhythmia as was engendered in the E.E.G. Such a process could hardly be expected to flourish in the presence of a pre-existing organic cerebral pathology; and in fact, if a case of depression secondary to arteriosclerosis, syphilis, or pre-senile dementia is inadvertently given E.C.T. the usual recuperation is impeded or absent. In such cases not only may a permanent state of regression be inflicted but the organic deterioration may be accelerated. Incontinence of urine sometimes gives an early warning of this error.

The propriety of using psychotherapy with E.C.T. in depression has often been discussed (Moriarty and Weil, 1943; Osgood, 1944). It depends on the type of depression and how far it has progressed. Moderate psychotic depressions, such as can be treated under general hospital conditions or as voluntary cases, are frequently blended with neurotic complications. If treated by E.C.T. the psychotic depression clears and the relief may enable the neurotic element to make a spontaneous adjustment. If it does not, then psychotherapy is indicated, being often assisted by the previous dispersal of the depressive element of the illness. Selinski (1943) and Kalinowsky *et al.* (1944) have commented on the better accessibility to psychotherapy given to some patients by E.C.T. In this respect, severe certified depressions are no problem, since, obviously, strict psychotherapeutic techniques cannot be applied to an inaccessible patient, while in depression secondary to a

primary neurotic disorder E.C.T. is certainly to be avoided in favour of psychotherapy. These methods are complementary, and inadequate treatment is inevitable if all therapeutic effort is canalized in one or other direction for every case.

A final point should be made about the relation of E.C.T. and other physical treatment to terminology. There is a tendency to associate the term "psychotic" too exclusively with mental hospital types. It is sometimes overlooked that there are at least as many cases of psychotic-type depression outside such hospitals whose treatment is equally urgent—and more so, since they are usually without proper observation and exposed to suicidal risks. In some a well-integrated personality can survive the stress of a mild psychotic depression, while in others the relatively sound integration may conceal severe symptoms even from those in closest contact, so that the final tragedy surprises all concerned. These patients respond well to E.C.T., and give results comparable to any in general medicine; none the less, these findings should deter the inexperienced but enthusiastic therapist from "pressing the button" without a satisfactory preliminary investigation of those appearing to be depressed, otherwise definite harm may be done to the patient. Repeated careful psychiatric examination before, during, and after treatment is the most important aspect of convulsion therapy—more so than the careful management of the actual fits.

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TECHNIQUE FOR THE USE OF d-TUBOCURARINE CHLORIDE WITH BALANCED ANAESTHESIA

BY

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The novelty of curare has passed, and the site of action, physiology, and pharmacology of the drug have been the subjects of many recent publications (see Gray and Halton, 1946). It is thought that a description of the methods employed in the administration of *d*-tubocurarine chloride (B. W. & Co.) in some 1,500 cases might be opportune. For the sake of brevity in the ensuing discussion *d*-tubocurarine chloride (B. W. & Co.) will be referred to as curarine.

Apparatus

Solutions of curarine and the quick-acting intravenous barbiturates are non-miscible. It is necessary here to correct a misunderstanding that may have arisen through a previous statement that curarine dissolves in excess pentothal solution. This is perfectly correct when applied to the pure crystalline powder. However, the solution now supplied by the makers

contains a harmless stabilizing agent which renders irreversible the precipitate formed with the barbiturates. To overcome this precipitation and to ensure that the intravenous needle will remain clear, in position, and under control during the operation three pieces of apparatus are suggested for use in the techniques described below:

1. A simple on-and-off tap (Fig. 1) with Record mountings. (Obtainable from M. & I. E. & Co., Ltd., London.)

FIG. 1

2. A three-way tap mounted on a plate which can be strapped to the arm (Fig. 2). The tap itself may be detached from the plate for purposes of sterilization. One inlet is connected to an intravenous drip of saline, plasma, or blood. A Record syringe containing the solution to be injected is connected to the other inlet.

FIG. 2

The outlet is attached to two inches of fine-bore, transparent Portex tubing, which in turn leads to the needle (obtainable from Alexander Fowler & Co., Ltd., Liverpool).

3. The remote-control tap is described elsewhere by Gray and Osborne (1946)—a rather more elaborate method but having the advantage of ensuring perfect control with the arm in any position.

Premedication

Very light premedication is advocated. In these days of intravenous induction of anaesthesia there is no necessity for heavy sedation, and the respiratory depression it produces is harmful. For adults morphine gr. 1/6 (11 mg.) with atropine gr. 1/150–1/100 (0.4–0.65 mg.) has been the routine, but this is modified where age or the condition of the patient so demands. It has been found useful to substitute dilaudid gr. 1/32 (2 mg.) or pethidine 50–100 mg. when there is a history of excessive vomiting after previous anaesthesia. The time of administration of the pre-operative drugs is all-important: they should be given 1–1½ hours before the operation starts.

Technique of Administration for Short Procedures

This anaesthesia is suitable for all endoscopic investigations, but particularly for bronchoscopy and oesophagoscopy by virtue of the complete relaxation of the vocal cords and the pharyngeal sphincter. It is also of value in the re-suture of burst abdominal wounds. A single injection of 15 mg. of curarine is followed by a suitable dose of barbiturate, both given intravenously. In all cases under review 0.5 g. of pentothal or 0.75 g. of "kemithal" (Macintosh and Scott, 1946; Gordon and Gibbons, 1946; Halton, 1946) have been used initially.

The simple tap described above (Fig. 1) is connected to a needle size 15. A tourniquet is applied round the selected arm and venepuncture performed with the tap in the "off" position. Entry into the vein is confirmed by a reflux of blood when the tap is turned on. The tourniquet is released and three successive injections made: 1.5 ml. of curarine solution, followed by 2–3 ml. of sterile normal saline to wash through

the tap and the needle, and finally the barbiturate solution, which should be given as quickly as the bore of the needle and the syringe permit, the whole manœuvre to be carried out cleanly and speedily.

Satisfactory anaesthesia, indicated by complete relaxation of the jaw, speedily ensues. The pulse rate and respiration must be under constant observation. The respiration ceases for from 30 seconds to one minute and a half, but is usually resumed before any degree of cyanosis or harmful anoxia can occur. Oxygen must always be administered. This is most easily done through the side-tube on a bronchoscope, through a catheter introduced into the trachea in the case of oesophagoscopies, and in other cases through a pharyngeal airway. At any time cyanosis must be countered by the immediate institution of "aided respiration," described later.

The above dosage is applicable to adults of average age and in fair condition. In elderly patients there must be some proportional reduction in dosage, and in children the correct dosage of curarine solution is 0.2 ml. (2 mg.) per stone (6.4 kg.) body weight. After doses of this order patients usually recover their protective reflexes and have full respiratory function in seven to ten minutes; but should this not occur they are retained in the theatre until there is no fear of respiratory obstruction or depression.

Technique of Administration for Longer Procedures

This is essentially a balanced anaesthesia. After induction the patient is maintained in a light plane by means of an intravenous barbiturate. The curarine produces relaxation and at the same time so reduces the amount of the barbiturate which has to be used that there is no delay in recovery. The exhibition of any of the inhalational agents is possible without causing laryngeal spasm. Their addition is useful when excessive manipulation or other factors arising during the operation demand a momentary deepening of the anaesthetic plane. Only minimal amounts of these agents are ever required. With very little experience the quantity of the barbiturate, the curarine, and the inhalational anaesthetic can be so estimated that no excessive amounts of any single one of them will produce a delay in post-operative recovery.

Control of respiratory exchange is essential in order to ensure that oxygenation is adequate and carbon dioxide eliminated. This is best attained by use of a closed circuit. The circuit must be completely free from leaks, and the application of the mask to the face made really air-tight by packing gauze inside the cheeks and the use of the Moreland Smith (1944) chin prop. When curarine is used in effective doses the tidal air is reduced. The inspiratory phase of the respiration must be amplified by rhythmic manual pressure on the re-breathing bag. This is "aided" rather than "controlled" respiration.

Adequate ventilation of the lungs is always possible through a pharyngeal airway of good design. Although endotracheal intubation under vision is simple when curarine is used it is considered necessary only where the site and nature of the operation preclude the use of a mask, in thoracic operations when bronchial occlusion or suction drainage is required, or in cases of intestinal obstruction when there is a danger of regurgitation of abdominal contents. It is useful occasionally in operations on the gall-bladder in the very obese.

Dosage

The use of either the three-way tap or the remote-control device of Gray and Osborne greatly facilitates the repeated intravenous injections required in these longer procedures.

Fifteen mg. of curarine are injected. When the patient is unable to keep his eyes open this is followed by either 0.5 g. of pentothal or 0.75 g. of "kemithal." After the lapse of two minutes intubation under direct vision can be performed if necessary, or an airway can be inserted and the anaesthetic mask placed in position without cough or spasm. Before the skin incision is made 0.2–0.4 g. of pentothal or 0.4–0.8 g. of "kemithal" is injected, and in the case of abdominal operations this is fortified by 0.5–1.0 ml. (5–10 mg.) of curarine. When the case is one for thoracotomy the curarine is injected just before the opening of the pleural cavity. As a general

rule slightly larger amounts will be required to control the diaphragm than will be found necessary in abdominal work. In thoracoplasties curarine is used at induction, and again to control the diaphragm and excessive respiratory movements if an apical mobilization is performed. During the operation slight movements or attempts at phonation, preceded by a rise in pulse rate, indicate the necessity for small increments of the barbiturate: these are in the nature of 0.1–0.2 g. of pentothal, or 0.2–0.4 g. of "kemithal."

A resistance to the inflation of the chest encountered by the hand on the re-breathing bag is the first indication that more curarine is required. This is added in doses of 2–4 mg. It is recommended that no curarine be given during the last twenty minutes of the operation, and the total dosage should not exceed 30–35 mg. The maximum amount of barbiturate that is used in long cases should not exceed 1.5 g. of pentothal or 2.5 g. of "kemithal." During the operation any approach to these maximal doses is anticipated, and a small amount of an inhalation agent, usually cyclopropane, is introduced into the circuit.

Experience has shown that this balanced technique results in far less post-operative morbidity than if the anaesthesia were either solely inhalational or solely intravenous.

Discussion

There is a rationale for the use of curarine. The drug should not be considered merely as an "aid" to anaesthesia, the last resort in a difficult administration; it is more—it is an integral part of the anaesthetic procedure. This is by virtue of four important properties: (a) it is quickly eliminated, leaving no toxic after-effects; (b) it produces relaxation as and when desired; (c) it abolishes laryngeal and bronchial spasm, making intubation of the trachea necessary only in selected types of cases; (d) because of the undoubted synergistic action with the anaesthetic agents the dose necessary to keep a patient asleep can be considerably reduced.

If these four properties are borne in mind, and if a correctly balanced anaesthesia is maintained, patients after long abdominal and thoracic operations are awake, in good vasomotor equilibrium, free from nausea, and able to exert their respiratory functions to the full. There is in consequence a smooth post-operative convalescence.

The drug may be given subcutaneously or intravenously. The first method need only be mentioned to be dismissed; it has no place in anaesthesia. When it is given intramuscularly the action is delayed for approximately fifteen minutes—often it is longer—and a maximum effect may not be seen for thirty minutes. It is obviously difficult to judge the injection so that relaxation will be present when and only when it is required. Furthermore, the duration of the action of the drug by this route is uncertain, especially when some degree of shock has reduced the absorptive functions of the circulation. In such cases there is a very great likelihood that the anaesthetist may be faced at the end of the operation with a patient whose respirations are laboured, who is unable to cough, and who is in urgent need of artificial respiration with oxygen. This is a very undesirable state of affairs, the proof of which lies in the proportion of post-operative chest complications seen when this technique is employed (Prescott, Organe, and Rowbotham, 1946). The same report advocated the use of an intravenous injection of curarine for induction with subsequent maintenance by the intramuscular route. This was tried early in the present series under discussion and abandoned for the reasons already given.

In conclusion, there are rare occasions when physostigmine, the physiological antidote to curarine, may be useful. It must be given in large doses and with atropine to prevent the undesirable parasympathomimetic effects. Prostigmin 3–5 mg. with atropine gr. 1/50 (1.3 mg.) has proved an effective combination.

There appear to be no real contraindications to the use of curarine provided that the administrator has a sound knowledge of the technique of its use and is familiar with the care of a patient in whom the usual signs of anaesthetic depth are absent, and where the natural process of respiratory exchange is impaired or completely abolished.

Summary

The technique of administration of *d*-tubocurarine chloride in some 1,500 cases is reviewed and the requisite apparatus described.

The rationale of its use is discussed and the various forms of parenteral administration assessed.

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SOME USES OF THROMBIN IN THE SURGERY OF THE EAR, NOSE, AND THROAT

BY

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In the surgery of the ear, nose, and throat many problems exercise the ingenuity and tax the patience of the surgeon. This paper is concerned with only two of these problems. The first is the control of bleeding, the second the healing of raw bony surfaces which have been deprived of their diseased covering by the removal of infected bone and granulations in the course of a radical mastoidectomy or similar operation.

Great reliance is commonly placed on the use of packing. Gauze is packed into one cavity to arrest bleeding; it is forced into another to control the overgrowth of granulations. Not only does the use of such a method frequently fail of its purpose, but also it favours continued infection and delay in healing. No evidence is needed of the discomfort such a gauze pack causes, or of the pain which its withdrawal inflicts.

The employment of thrombin enables the surgeon to dispense with packing in some situations where before it was essential. It is the purpose of this paper to indicate in what ways it can be so used.

Mellanby first prepared thrombin in 1933. The addition of thrombin to blood or plasma causes the formation of a clot. The ampoule in which it is supplied contains 5,000 Iowa units.* One such unit is the amount of thrombin which will clot 1 ml. of standard fibrinogen solution in 15 seconds. With the ampoule containing the thrombin powder is another holding 5 ml. of sterile water, in which the thrombin powder is readily soluble. The rate of action of the thrombin can be varied by using more or less of the solvent. By using less solvent the surgeon obtains a fluid which clots plasma quicker than will a more dilute solution. It should never be injected into the tissues.

Control of Haemorrhage

The Throat.—Brisk arterial or venous bleeding does not respond to the action of thrombin (Ingraham and Bailey, 1944). Personal experience of its employment in tonsillectomy confirms this. An attempt was made to provide a firm clot in the tonsillar fossa by spraying the raw surfaces with thrombin solution after the larger vessels had been picked up and tied. This technique was followed in 166 tonsillectomies, but it did not, as had been hoped, prevent the occasional case of reactionary haemorrhage. Its use was therefore discontinued.

The Ear.—Thrombin has proved of great value in the control of oozing from small vessels. It is this bleeding which is such an embarrassment to the surgeon in the narrow field of the mastoidectomy wound. Constant oozing hides important bony landmarks, such as the torus of the external semicircular canal, and causes loss of time in the performance of the operation. After ligation of such vessels as can be picked up with a haemostat a few drops of the thrombin solution are run over the wound cavity. In a few moments a clot forms; this should be left undisturbed for 30 seconds or so. The outer layers of the clot can then be aspirated, leaving a fine film of clot over the whole surface.

* Thrombin, Topical, P.D., has been used in this series.