Dimethyl tubocurarine iodide does not produce this precipitation. Solutions in thiopental, hexobarbital and at hydrogen ion concentration similar to that used with tubocurarine had potency equal to solutions in distilled water.

Flaxedil® (Lederle) was also unaffected by either barbiturate or by a wide range in hydrogen ion concentration.

Mytolon® (Winthrop) was not noted to show precipitation or diminution of potency under similar conditions.

Decamethonium bromide in the same solutions was observed to have unreduced potency.

Succinylcholine dichloride, also known as diacetylcholine, is an agent whose effect lasts about five minutes, and from which recovery, in the pentobarbital-anesthetized dog, is nearly complete, even with continued administration. It is destroyed almost immediately by a pH of over 11.0, more slowly between pH 9.5 and 11.0, and little at all below 9.5.

Thus, mixtures with thiopental, if given immediately, are effective, but in five minutes the potency is reduced considerably.

Hexobarbital mixtures (effective dose in two volumes of 10 per cent hexobarbital) are destroyed immediately, but by increasing the proportion of succinylcholine to hexobarbital, this can be delayed five or ten minutes.

OC 1130–2602 is 3-trimethylamoniumpropyl p-trimethylamoniumbenzoate dibromide. Its duration of action and many of its effects in experimental animals are similar to those of decamethonium. In the anesthetized human being moderate fasciculation has been noted. The length of action of this drug compares more favorably with *d*-tubocurarine rather than decamethonium bromide. No tendency toward tachyphylaxis or marked respiratory depression has been noted in 50 clinical patients. It is rendered ineffective slowly below pH of about 11.0, not at all below 9.0. Above pH 11.0 it appears to be completely and rapidly destroyed. Therefore, in solution with hexobarbital (pH 11.7) it is ineffective. In solution with thiopental (pH 10.7) it may produce the predicated paralysis, if given promptly.

It is desirable to emphasize that this procedure does not give a precise quantitative estimate of curariform activity, but is thought to give a more adequate visual record than can be obtained clinically. The preparations were tried in mice, by intraperitoneal and intravenous routes, using inability to hang on a wire screen as an end point, to illustrate that the same results could be obtained with another procedure.

This study was thought useful, not so much as a test of the compatibilities of the compounds in established usage, but to caution against the use of drug mixtures in the evaluation of new agents.

J. B. BRITTON, M.D.,
Assistant Professor,
Department of Pharmacology,
Medical College of Georgia, AND
PERRY P. VOLPITTO, M.D.,
Professor,
Department of Anesthesiology,
Medical College of Georgia,
Augusta, Georgia

THE USE OF SUCCINYLCHOLINE FOR ENDOTRACHEAL INTUBATION

Recently, the use of succinylcholine,* an ultra-short acting, "depolarizing" (1) type of muscle relaxant was introduced to anesthesiology (2–5). Succinylcholine differs from the previously employed muscle relaxants in that it is hydrolyzed by both the plasma cholinesterase (nonspecific cholinesterase) and the acetylcholine esterase (true cholinesterase) (6–10). Owing to this enzymatic hydrolysis the duration of the effect of a single intravenous dose is very brief. This circumstance makes succinylcholine suitable for the production of muscular relaxation of short duration.

Succinylcholine was used for the production of muscular relaxation prior to endotracheal intubation in 317 unselected pa-

* Succinylcholine in the form of succinylcholine diiodide was employed in these studies and was made available to us through the courtesy of Dr. E. J. de Beer of Burroughs Wellcome & Co.

tients anesthetized with pentothal sodium. In 202 patients, muscular relaxation was maintained by the continuous intravenous infusion of a dilute succinylcholine solution. The observations made on this group will be reported elsewhere (5). In the remaining 115 patients no more muscle relaxant was used after the intubation, either because the surgical procedure did not require muscular relaxation or because anesthesia was maintained by ether that in itself provided adequate relaxation.

TECHNIC OF INTUBATION

After premedication with 100 to 200 mg. of pentobarbital, sixty to ninety minutes, and 0.2 to 0.6 mg. of scopolamine hydrobromide with 5 to 15 mg. of morphine sulfate, forty-five minutes before induction of anesthesia, the patient's nasopharynx and oropharynx were sprayed with a few cubic centimeters of 1 per cent pontocaine solution. Anesthesia was then induced by the intravenous administration of a 2.5 per cent solution of pentothal sodium. When the depth of anesthesia reached planes 1 or 2 of stage III, 15 to 45 mg. of succinylcholine diiodide was administered intravenously in about fifteen seconds. Muscular relaxation was complete forty-five to seventy-five seconds after the end of the injection of succinylcholine. At that time, the cords were visualized by direct laryngoscopy and sprayed with a 1 per cent solution of pontocaine. If there was no sign of laryngeal irritability, an endotracheal tube was inserted. When the spraying evoked a laryngeal reflex, an additional dose of pentothal sodium was administered, an oral airway was inserted and the patient was given oxygen by mask for twenty to thirty seconds. The cords were again visualized and the tube inserted. Endotracheal intubation had to be completed within three minutes of the start of the administration of succinylcholine because, with correct dosage relaxation starts to wear off at the end of the third minute.

RESULTS

The doses of pentothal sodium and succinylcholine diiodide used before intubation are shown in table 1. Although there was considerable variation in the average dose of pentothal sodium, the dose of succinylcholine diiodide was 30 mg. in the majority of cases. With a few exceptions, this dose produced good relaxation of the jaw musculature and the larynx without causing respiratory arrest. In general, the dose of succinylcholine could be judged fairly well from the age, weight, build and physical condition of the patients. Old, thin, flabby patients in poor physical condition needed less succinylcholine than young, heavy, muscular patients in good physical condition. In those instances in which the dose of succinylcholine was misjudged, an overdose produced respiratory depression which lasted from thirty to 150 seconds. This occurred in 5 of our patients. When the dose of succinylcholine was inadequate, the administration of an additional 10 to 15 mg. of succinylcholine diiodide gave optimal conditions for endotracheal intubation.

As already mentioned, the effect of a single intravenous dose began to wear off in three minutes. With very few exceptions, when an overdose was given, the effect completely disappeared within five minutes of the start of administration of succinylcholine. The return of normal respiratory tidal volume soon after endotracheal intubation made the use of assisted respiration unnecessary, and it produced ideal conditions for transition to inhalation anesthesia. In several instances, especially when succinylcholine was injected rapidly, mild muscular twitchings developed. These lasted 5 to 15 seconds and usually were accompanied by an increase in the depth of respiration.

No other unwanted side effects were observed after the use of succinylcholine. Excessive salivation, tachycardia, bradycardia, hypertension, hypotension and bronchospasm, which occur occasionally with the

TABLE I

SUCCINYLCHOLINE DIIODIDE AND PENTOTHAL SODIUM USED BEFORE INTUBATION

	Range, mg.	Average, mg.
Succinylcholine diiodide	10.0–50.0	30.2
Pentothal sodium	250.0–1000.0	577.0

various other muscle relaxants, were not seen in any of our patients.

COMMENT

Various muscle relaxants have been used extensively prior to endotracheal intubation. Depending on the agent used, three to eight minutes were required for the development of maximal effect (11). After a single intravenous injection, the duration of their action varied between ten to thirty minutes, and consequently a certain degree of respiratory depression was present for varying lengths of time after there was no further need for muscular relaxation. Furthermore, if d-tubocurarine or metubine with pentothal sodium is used for intubation in cases in which anesthesia is to be maintained with ether-oxygen, respiratory arrest will frequently develop in the course of transition to ether anesthesia, and noticeable respiratory depression may be present for a considerable period.

In contrast to this, maximal response developed in sixty to ninety seconds after the intravenous administration of succinylcholine, and no respiratory depression was seen after five minutes.

The occasional twitching observed after the administration of succinylcholine can also be seen after the use of syncurine, and it can also be seen after the intra-arterial injection of acetylcholine. This phenomenon is caused by the depolarization of the neuromuscular membrane, which in turn initiates the action potential that results in muscular contractions (1).

The advantages of succinylcholine as a muscle relaxant for endotracheal intubation are the following: (1) rapid onset of action; (2) short duration of action which obviates the use of assisted respiration and facilitates the saturation of patients with inhalation anesthetic agents without interfering with the signs of anesthesia; (3) short duration of respiratory arrest even when an overdose is administered as a result of error in judgment and (4) no unwanted side effects of any importance.

The only apparent disadvantage of the use of succinylcholine for endotracheal intubation is that it allows only sixty to ninety seconds for its peformance when a single intravenous dose is used. Although this time is more than adequate for the experienced anesthesiologist, occasionally it will not be sufficient for the novice learning the technic. This difficulty does not arise when muscular relaxation is maintained by the continuous intravenous infusion of succinylcholine, and can be corrected in other cases by the administration of a second fractional dose.

SUMMARY

The use of succinylcholine for the production of muscular relaxation prior to endotracheal intubation was described in 317 cases. Owing to the rapid onset and short duration of its action, succinylcholine is the agent of choice, especially in those cases in which no further muscular relaxation will be required after endotracheal intubation, or when muscular relaxation will be maintained with an inhalation anesthetic agent.

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FRANCIS F. FOLDES, M.D.,
AND PEARL G. MCNALL, M.D.,
Department of Anesthesia,
Mercy Hospital,
Pittsburgh, Pa.,
and
Section on Anesthesiology,
Department of Surgery,
University of Pittsburgh,
School of Medicine,
Pittsburgh, Pa.

UNUSUAL COMPLICATION OF NASAL INTUBATION: REPORT OF CASE

A markedly obese woman, 61 years old, was admitted to the hospital for a hemorrhoidectomy. The patient was as adamant in her refusal of spinal or caudal analgesia as was the surgeon in his demand for the Buie position. Confronted with this undesirable combination, I selected an endotracheal technic as the method of choice. Since the patient was of short-necked type in whom it is usually easy to perform intubation blindly by the nasal route, this approach was chosen.

Anesthesia was induced, using a cyclopropane-ether sequence. Partial obstruction commenced simultaneously with loss of consciousness, and required early introduction of an oropharyngeal airway. When the patient was in the second plane of surgical anesthesia, an attempt was made to pass a number 30 French Magill endotracheal tube into the right nostril. Some resistance was encountered, so the left side was tried. However, this side seemed completely impassable, so the right side was employed. A slight degree of resistance was encountered when the tube was passed but, after insertion, no breath sounds were audible at the proximal end of the tube although the patient was respiring freely.

Because of the fear that a foreign body might have been encountered during passage of the tube, with subsequent occlusion of its lumen, or that the tube had entered the esophagus, direct laryngoscopy was resorted to with the tube still in place.

No foreign body, mucus or blood was seen in the pharynx and larynx, but the endotracheal tube could not be visualized. Just to the right of the midline, however, the mucous membrane of the posterior pharyngeal wall bulged. With manipulation of the tube, this bulge was seen to advance and recede with insertion and withdrawal of the tube. At no place in the region under observation was any rent detected in the mucous membrane.

The tube was removed and orotracheal intubation was contemplated when the surgeon, sensing some difficulty with the conduction of the anesthesia, volunteered to carry out the surgical procedure with the patient in the lithotomy position.

It is postulated that the endotracheal tube dissected beneath the mucous membrane at the mucocutaneous junction shortly after it entered the right nostril.

After operation, the patient was not interrogated specifically about nasal or pharyngeal discomfort and, strangely enough, complained of none.

WILLIAM M. DALY, M.D.,
Rochester General Hospital,
Rochester 3, N. Y.