The neuromuscular effects of suxamethonium (single dose and continuous infusion) were determined in anaesthetized patients. A marked variation in patient response was observed. The block was initially depolarizing but with increasing dosage and time became desensitizing. Tachyphylaxis was observed with repeated doses of suxamethonium but not with continuous infusion. The depth of anaesthesia was an important factor in determining the amount of suxamethonium required to produce satisfactory operating conditions. If suxamethonium was infused continuously for no more than 1 hour or infused intermittently for several hours, recovery was always rapid (3–21 minutes). However, in four of nine patients who received suxamethonium by continuous infusion for 2 hours recovery required 51–69 minutes.

Suxamethonium and tubocurarine are the most commonly used neuromuscular blocking agents. In a previous study of tubocurarine a marked variation in patient response was observed (Katz, 1967). Studies in which the effects of suxamethonium were clinically assessed suggested a similar variation (Foldes, McNall and Borrego-Hinomosa, 1952; Little, Hampton and Grosskreutz, 1953; Foldes and Norton, 1954; Borders et al., 1955; Helmsworth and Schotz, 1955, 1956; McNally, Neily and Benoit, 1962.) However, there are few data available in which the variation in patient response to suxamethonium has been assessed with the aid of a nerve stimulator. This is especially true for continuous infusion of the drug.

The results and interpretation of previous studies have raised questions concerning the nature of the block, depolarizing (phase I) or desensitizing (phase II), produced by suxamethonium. One extreme is that the block is always depolarizing, even with doses as large as 1000 mg (White, 1953). Others have suggested that the block is initially depolarizing but changes to desensitizing, (1) in all patients (Foldes et al., 1957), (2) in some patients after large doses (500–1500 mg) (Churchill-Davidson, Christie and Wise, 1960), (3) in most or all patients after small doses (100–300 mg) (Katz, Wolf and Papper, 1963; Crul et al., 1966), or (4) in some patients depending upon how the drug is given (Walts and Dillon, 1967). The other extreme is that the block is always desensitizing even with the first small dose (de Jong and Freund, 1967). A related area of controversy is whether repeated injection of the same dose of suxamethonium produces a change in the nature of the block and a greater duration of action (Crul et al., 1966; Walts and Dillon, 1967; Wylie and Churchill-Davidson, 1966), a lesser duration of action (Poulsen and Hougs, 1958; Payne and Holmdahl, 1959; Katz, Wolf and Papper, 1963), or neither tachyphylaxis nor a cumulative effect (Thesleff, 1952).

The present study will attempt to answer the following questions:

1. How much variation is there in the response of patients to suxamethonium?
2. What is the dose of continuously infused suxamethonium required to maintain a 90 per cent depression of twitch height?
3. Is there a cumulative effect or does tachyphylaxis occur when repeated single doses or continuous infusion suxamethonium is used?
4. How rapid is recovery from a single dose, repeated doses or continuously infused suxamethonium?
5. Does the depth of anaesthesia affect muscle relaxation?

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(6) What is the nature of the block produced by suxamethonium?

**METHODS**

Studies were carried out during anaesthesia and operation on patients with no known neuromuscular abnormalities. Most of the patients received atropine or hyoscine (0.4–0.8 mg), pentobarbitone (50–100 mg) and/or pethidine (50–100 mg) for pre-anaesthetic medication. Anaesthesia was usually induced with thiamylal 150–500 mg and maintained with nitrous oxide supplemented by thiamylal, pethidine, trichloroethylene or halothane. Tracheal intubation was carried out, when necessary, with the aid of suxamethonium (0.5 mg/kg usually). Respiration was spontaneous, assisted or controlled as clinically required. Spot checks of arterial pH and Pco₂ were made to assist in maintaining their values at or near control levels.

Neuromuscular transmission was studied in a manner previously described (Katz, 1965). Briefly, the ulnar nerve was stimulated and the adduction of the thumb (attributable mainly to the adductor pollicis brevis muscle) measured with a force displacement transducer (Grass model FT-03 or FT-10) and recorded on a polygraph. The stimulus was usually derived from a Grass stimulator (model S4) through a stimulus isolation unit. The pulses were 0.1–0.2 m.sec duration, 0.1–0.3 Hz frequency and supramaximal intensity. At appropriate intervals tetanic stimuli (30, 50, 100 or 200 Hz) were applied for 3–5 seconds.

The responses to 0.5, 1.0, 2.0 and 3.0 mg/kg of suxamethonium were determined without any prior suxamethonium being given. A single dose of 5 mg/kg or a continuous infusion was given only if the duration of block produced by a test dose of 0.5 mg/kg was less than 30 minutes, the maximum duration seen in apparently normal patients in our experience. Suxamethonium was continuously infused by means of a constant infusion pump or rarely by gravity drip.

When the twitch height was 10–20 per cent of control the nature of the suxamethonium (depolarizing or desensitizing) was determined by the post-tetanic response. Although the sustainment of tetanic response has been commonly used to determine the nature of the block this may sometimes be misleading since tetanus may be well sustained despite a non-depolarizing block produced by tubocurarine, dimethyl tubocurarine or a desensitizing block produced by suxamethonium (Katz, 1967; Katz, unpublished data). Therefore, post-tetanic facilitation was used to assess the block. For the block to be considered desensitizing the degree of post-tetanic facilitation must be such that the maximally facilitated twitch is two or more times greater than the non-facilitated twitch. Although with tubocurarine the twitch prior to tetanus can be used as the control against which the facilitated twitch is compared, erroneous conclusions may be drawn if a similar criterion is used with suxamethonium, especially a small dose. Since recovery from suxamethonium is rapid, there may be substantial spontaneous recovery between the last twitch prior to tetanus and the first twitch after tetanus, so that the magnitude of post-tetanic facilitation may appear to be greater than it really is (fig. 1). Added to this is the fact that even with a steady level of block the new steady level of twitch height after tetanus may be greater than before tetanus, a phenomenon also seen with tubocurarine and referred to as post-tetanic decurarization. To avoid possible misinterpretation we currently compare the maximum and minimum twitch after tetanus and if the magnitude of post-tetanic facilitation is 200 per cent or greater we label the block desensitizing. Where possible a desensitizing block is confirmed by demonstrating that edrophonium antagonizes the block, i.e. increases the twitch height.

It should be pointed out that the choice of 200 per cent post-tetanic facilitation is arbitrary. As previously pointed out (Katz, Wolf and Papper, 1963; Churchill-Davidson and Katz, 1966) the change in nature of the block is not an abrupt one, and the state of affairs may differ from muscle fibre to muscle fibre. The 200 per cent figure was chosen since at this point edrophonium will antagonize the block, provided that the suxamethonium has been discontinued and there is some recovery of neuromuscular transmission.

**RESULTS**

*Intravenous injections of 0.5–5 mg/kg.*

The injection of 0.5–5 mg/kg of suxamethonium abolished the twitch in all fifty patients.
Calculation of magnitude of post-tetanic facilitation during recovery from suxamethonium.
Panel A: The first twitch after tetanus (↑T) is twice as large as the last twitch before tetanus. This is in part due to post-tetanic facilitation and in part due to spontaneous recovery. Note that the first twitch after tetanus is less than twice the height of the smallest twitch after tetanus. The block is therefore considered depolarizing in nature.
Panel B: Note that the first twitch after tetanus is greater than twice the height of the lowest twitch after tetanus. The block is now desensitizing in nature. See “Methods” for additional comments.

**TABLE I**

Variations in response to suxamethonium 0.5–5.0 mg/kg.

<table>
<thead>
<tr>
<th>Dose (mg/kg)</th>
<th>No. of patients</th>
<th>Recovery-time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>0.5</td>
<td>20</td>
<td>1.5–9.4 (5.5)</td>
</tr>
<tr>
<td>1.0</td>
<td>10</td>
<td>4.1–15.4 (10.2)</td>
</tr>
<tr>
<td>2.0</td>
<td>10</td>
<td>7.0–19.1 (13.1)</td>
</tr>
<tr>
<td>3.0</td>
<td>10</td>
<td>9.6–21.5 (15.2)</td>
</tr>
<tr>
<td>5.0</td>
<td>10*</td>
<td>20.2–28.0 (23.4)</td>
</tr>
</tbody>
</table>

Range of recovery time listed with mean values in parentheses.
* These 10 patients received a test dose of suxamethonium 0.5 mg/kg and are included in the 20 responses reported for 0.5 mg/kg.

Data on recovery to 10, 25, 50 and 90 per cent of control are listed in table I. Unless otherwise indicated the duration of action or recovery time referred to is the time from the first depressed twitch to 90 per cent return of twitch height. The 90 per cent return was used since recovery above this level is asymptotic, making accurate determination of full recovery difficult. In addition, recovery to greater than control levels was usually seen, varying from 110 to 160 per cent of the initial level. The duration of action of 0.5 mg/kg varied from 4.2 to 16 minutes (fig. 2), of 1 mg/kg varied from 8.3 to 21 minutes, of 2 mg/kg varied from 12.2 to 24.1 minutes, of 3 mg/kg varied from 15.1 to 28 minutes and of 5 mg/kg varied from 26.6 to 53 minutes. The variation in response was greater for the smaller doses than for the larger ones (table I, fig. 2). None of the patients who received 0.5–2 mg/kg developed a desensitization block, as defined, but such a block was seen in 10 per cent of the patients who received doses of 3–5 mg/kg.
Variation in response to suxamethonium in two patients (A and B). At each arrow 0.5 mg/kg was injected intravenously.

Recovery (min) from 0.5 mg/kg was (as shown above):

<table>
<thead>
<tr>
<th>Recovery Level</th>
<th>Patient A</th>
<th>Patient B</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>1.5</td>
<td>9.4</td>
</tr>
<tr>
<td>25%</td>
<td>2.0</td>
<td>10.6</td>
</tr>
<tr>
<td>50%</td>
<td>2.75</td>
<td>12.20</td>
</tr>
<tr>
<td>90%</td>
<td>4.2</td>
<td>16.0</td>
</tr>
</tbody>
</table>

The duration of action of 5.0 mg/kg (not shown above) varied less than did 0.5 mg/kg, particularly for the 10 per cent recovery period.

Recovery (min) from 5.0 mg/kg was (not shown above):

<table>
<thead>
<tr>
<th>Recovery Level</th>
<th>Patient A</th>
<th>Patient B</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>20.2</td>
<td>28.0</td>
</tr>
<tr>
<td>25%</td>
<td>22.1</td>
<td>35.4</td>
</tr>
<tr>
<td>50%</td>
<td>24.3</td>
<td>41.5</td>
</tr>
<tr>
<td>90%</td>
<td>26.6</td>
<td>53.0</td>
</tr>
</tbody>
</table>

Tachyphylaxis with repeated doses of suxamethonium. 0.5 mg/kg injected at arrows in panels A, B and C.

Panel A shows the first response to suxamethonium. Panel B shows the sixth response. Panel C shows the eleventh response.

Note decrease in magnitude and duration of action with repeated injection.
Repeated doses of 0.5 mg/kg.

Ten of the patients who received suxamethonium 0.5 mg/kg each received ten additional doses of 0.5 mg/kg. Each additional dose was given 15 minutes after the twitch height had returned to a stable level following the previous dose. In five of the ten patients receiving eleven doses tachyphylaxis (a consistent decrease in degree and/or duration of action greater than 20 per cent) was observed (fig. 3). In the remaining five patients the magnitude and duration of action of the eleventh dose was similar to that observed after the first dose (fig. 4). In all ten patients the block after the first dose was depolarizing but after the eleventh dose desensitizing. In five of these ten patients a twelfth dose of suxamethonium was given and during recovery the response to edrophonium determined.

Four patients who were operated on more than once received ten injections of suxamethonium 0.5 mg/kg at the first operation and a single injection of 5 mg/kg at the second operation. The block after a single dose of 5 mg/kg was depolarizing but after 5 mg/kg in divided doses it was desensitizing.

Continuous infusion.

Fifty patients received suxamethonium by continuous infusion in a dose which produced a 90 (±10) per cent block for 1 hour (fig. 5). Once the proper infusion rate was established (this was usually accomplished within 15 minutes) it was rarely necessary to modify the rate and then only

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**Fig. 4**

Absence of tachyphylaxis or cumulative effect with repeated doses of suxamethonium. 0.5 mg/kg injected at arrows in panels A and B. Note similarity of responses to first (panel A) and eleventh (panel B) injections.

**Fig. 5**

Response to continuous infusion of suxamethonium for 1 hour. Panels A 1–4 continuous. At first arrow in panel A1, infusion started. At second arrow, rate of infusion decreased 10 per cent. Note fairly constant level of twitch height. At arrow in panel A4, infusion discontinued after total dose of 5.2 mg/kg/hr. Note rapid recovery.
Fast and slow recovery from continuous infusion of suxamethonium in two patients.

Panel A: At arrow administration was discontinued after 1 hour of infusion of 6.2 mg/kg/hr. Note rapid recovery.

Panels B 1–3 continuous. At arrow infusion was discontinued after 2 hours of 4.44 mg/kg/hr. Note slow recovery.

by 10 per cent. The dose required to maintain a 90 per cent block varied from 1.7 to 15.2 mg/kg/hr (mean = 5.2) or 2.7–11.4 mg/min (mean = 5.8).

When the infusion was discontinued after 1 hour (forty-one patients) recovery varied from 3 to 21 minutes (mean = 12.6 min) (figs. 5, 6A). In twenty-six (63 per cent) of these patients the block was depolarizing while in fifteen it was desensitizing in nature.

In nine of the above fifty patients infusion was continued for a second hour at the same rate, in order to determine whether the block would increase (indicating a cumulative effect) or decrease (indicating tachyphylaxis). Contrary to expectations the level of block remained constant or varied slightly (± 10 per cent) during the second hour. In six of these patients the block was desensitizing and recovery required 12, 17, 18, 51, 61 and 69 minutes. In three of the patients the block was depolarizing and recovery required 12, 17 and 54 minutes (fig. 6B).

Effect of depth of anaesthesia.

In preliminary studies it appeared that in the presence of light general anaesthesia (just sufficient to ensure that the patient did not move following the skin incision) muscular relaxation (as judged by the surgeon and anaesthetist) was usually satisfactory when the twitch response was depressed 75–90 per cent from control and always satisfactory at 90–100 per cent depression. However, in the absence of adequate anaesthesia, relaxation was no longer satisfactory despite a 90 per cent or even 100 per cent depression of twitch height. A similar observation was previously reported for tubocurarine (Katz, 1967). To study this further, ten patients received thiamylal-nitrous oxide-oxygen anaesthesia and a suxamethonium infusion which produced a 90 per cent block. After a stable period of at least 30 minutes, no additional doses of thiamylal were given. In each patient a point was reached at which relaxation was unsatisfactory despite a 90 per cent depression of twitch height. Injection of thiamylal 50 mg immediately restored satisfactory relaxation. In no case did thiamylal affect the twitch response.

To study this phenomenon from a different point of view twenty patients received a continuous infusion of suxamethonium as clinically indicated, with the person giving the anaesthesia being unable to see the degree of block. In the first hour of anaesthesia nitrous oxide was supplemented with thiamylal 250–500 mg (five patients)
or trichloroethylene 0.3–0.5 per cent (five patients) as clinically indicated, while in the second hour the nitrous oxide was not supplemented. In ten other patients the sequence was reversed. The amount of suxamethonium required for satisfactory relaxation during the unsupplemented periods was 37–108 per cent greater than during the supplemented periods. The twitch was abolished during 78 per cent of the unsupplemented period but only during 32 per cent of the supplemented period. The experimental design is such that the greater amount of suxamethonium required during the unsupplemented period is probably underestimated.

Intermittent infusion.
Fifty patients undergoing upper or lower abdominal surgery received suxamethonium only when muscle relaxation was required, rather than continuously. With light general anaesthesia, the infusion was usually given for 5–30 minutes at a time. The nature of the block and the speed of recovery were determined each time the infusion was stopped. The amount of suxamethonium given to these patients in the first hour of the operation varied from 2.3 to 5.1 mg/kg/hr (mean = 3.9). In the second hour twenty-one patients received 1.6–4.3 mg/kg/hr (mean = 3.1) and in the third hour six patients received 2.1–3.8 mg/kg/hr (mean = 2.8). Recovery under these circumstances required 3–16 minutes (mean = 10.3). The speed of recovery did not differ by more than 25 per cent in a given patient regardless of the total amount of drug received or the nature of the block. A desensitization block developed in thirty-seven (74 per cent) of the patients. The dose of suxamethonium which produced such a block varied from 1.9 to 10.8 mg/kg (mean = 5.0) and the time required ranged from 32 to 162 minutes (mean = 68).

Edrophonium.
The effect of edrophonium 0.15 mg/kg on twitch height was determined during a depolarizing block and during a desensitizing block produced by suxamethonium. With a depolarizing block seen after a single injection of 0.5 mg/kg (five patients) or after continuous infusion (five patients) edrophonium given during recovery antagonized the block. Thus edrophonium increased the depolarizing block, but antagonized the desensitizing block.

DISCUSSION

Variations in response.
In the present study the dose of suxamethonium given by continuous infusion required to maintain 90 per cent twitch depression varied from 1.7 to 15.2 mg/kg/hr or 2.7–11.4 mg/min. In other studies in which the drug was continuously infused, the dose clinically required varied among patients by a factor of 5 to 12 (Foldes, McNally and Borrego-Hinomosa, 1952; Little, Hampton and Grosskreutz, 1953; Helmsworth and Schotz, 1955, 1956; McNally, Neily and Benoit, 1962; Morris and Giesece, 1968). With single doses of suxamethonium we also observed a marked variation in duration of action, ranging from two- to fourfold. Others have reported a two- to fivefold variation in duration of action (Foldes and Norton, 1954; Borders et al., 1955). Because of this variation in patient response it would seem prudent to use a nerve stimulator to monitor the effects of suxamethonium, especially when given by continuous infusion.

Although the level of pseudocholinesterase (which hydrolyzes suxamethonium) can be a factor in determining the duration of action (Evans et al., 1952), it is unlikely that differences in these levels can fully explain the marked variations in responses (Hall, Lehmann and Silk, 1953; Foldes and Norton, 1954; Fraser, 1954; Borders et al., 1955; Argent, Dinnick and Hobbiger, 1955). Factors which may contribute to the variation in response to suxamethonium in normal patients include blood flow, distribution, and binding to plasma proteins and receptor proteins (Argent, Dinnick and Hobbiger, 1955; Dal Santo, 1968). The variation in response is similar to that previously reported for tubocurarine (Katz, 1967) and is also similar to the variation in sleep dose of thiamylal which in our experience has ranged from 50 to 1000 mg.

Change in nature of block.
It was pointed out in the introduction that controversy exists concerning the nature of block produced by suxamethonium. In the present study
it was observed that the initial block produced by suxamethonium was depolarizing in nature. A change to a desensitizing block depended not only upon the dose given but upon the method of administration, which involves a time-dose relationship. The duration of action is also affected by the method of administration and appears to affect the development of a desensitizing block. For example, although four patients who received ten doses of 0.5 mg/kg all developed a desensitizing block, none of these same patients developed a desensitizing block when given a single injection of 5 mg/kg on another occasion. In addition, the duration of block was greater when 5 mg/kg was given in divided doses over a longer period of time. This seems analogous to the observation of Walts and Dillon (1967) that one intravenous injection of 4 mg/kg did not produce a desensitizing block in five patients studied, but the same dose given intramuscularly produced a desensitizing block in eleven of fifteen patients studied, as well as a greater duration of action. Similarly, Crul and colleagues (1966) reported that the dose of suxamethonium required to produce a desensitizing block was more than two times greater for continuous infusion than for repeated injections.

The report of de Jong and Freund (1967) that suxamethonium does not produce a depolarizing block but only a desensitizing block is contrary to the present results and those of others (White, 1953; Foldes et al., 1957; Churchill-Davidson, Christie and Wise, 1960; Katz, Wolf and Papper, 1963; Crul et al., 1966; Walts and Dillon, 1967). A possible explanation lies in the criteria used. Although post-tetanic facilitation of greater than 200 per cent was accepted by de Jong and Freund (1967) as a criterion for desensitizing block, individual figures in their paper as well as their figure 7 scattergram demonstrate that post-tetanic facilitation of a lesser degree was observed. This suggests to the writers that a depolarizing block was seen. Furthermore, with small doses of suxamethonium the nature of the block changes rapidly and the first twitch after tetanus represents not only post-tetanic facilitation but also some degree of spontaneous recovery. Thus the true magnitude of post-tetanic facilitation may be less than they calculated it to be (see above in "Methods" and fig. 1). Finally, although they listed the effect of anticholinesterase drugs as a criterion for determining the nature of the block, responses of the block to these agents were not reported. The present authors found that edrophonium increased the depolarizing block but antagonized the desensitizing block. Whilst not disagreeing with the data of de Jong and Freund (1967), the authors disagree with their interpretation. The difference in interpretation is discussed at some length because of an awareness that others have extended the concept that suxamethonium does not produce a depolarizing but only a desensitizing block to imply that anticholinesterases can and should be used to antagonize the action of suxamethonium. This practice can be dangerous (Vickers, 1963; Gissen et al., 1966; Katz, personal communications).

**Tachyphylaxis v. cumulative effect.**

**Repeated injections.** Although it was originally reported that neither tachyphylaxis nor accumulation was seen with suxamethonium (Thesleff, 1952) tachyphylaxis on repeated injection was subsequently reported by a number of investigators (Payne and Holmdahl, 1959; Katz, Wolf and Papper, 1963; Crul et al., 1966), the incidence varying from 30 to 70 per cent. In the present study a 50 per cent incidence was noted, with the duration of action of the last dose of suxamethonium being 30–50 per cent shorter than the first dose. The presence or absence of tachyphylaxis could not be correlated with the nature of the block, as previously reported (Katz, Wolf and Papper, 1963; Crul et al., 1966).

**Continuous infusion.** Tachyphylaxis during continuous infusion of suxamethonium was reported in three patients by Payne and Holmdahl (1959) and in eleven of fifteen patients by Poulsen and Hougs (1958). The onset of tachyphylaxis was noted 40–60 minutes after the start of the infusion. Clinical reports of an increasing rate of infusion being required to maintain adequate operating conditions are not uncommon. On the other hand, it has been suggested that with increasing amounts of infusion, prolonged apnoea may result because of the development of a desensitizing block from which recovery is prolonged (Wylie and Churchill-Davidson, 1966). A similar prolonged recovery due to a desensitizing block has been implied by others (Crul et al., 1966; Walts and Dillon, 1967).
In light of the above the writers were surprised to find that once a steady level of block was established, the same rate of infusion could be continued for as long as 2 hours, with the block remaining constant, irrespective of whether it was depolarizing or desensitizing. Thus neither tachyphylaxis nor a cumulative effect was observed in terms of magnitude of action of suxamethonium (see below for duration of action). The apparent tachyphylaxis as reported may be related to the effect of depth of anaesthesia on suxamethonium requirement. It was clearly demonstrated in the comparison of supplemented and unsupplemented nitrous oxide that the amount of drug required to produce satisfactory relaxation was less during supplementation. This can be attributed to the ability of anaesthetics and barbiturates to produce muscle relaxation by central nervous system depression, without producing neuromuscular block (Katz and Katz, 1968).

Aetiology of prolonged response to suxamethonium.

In the authors' view the most common cause of a prolonged response to suxamethonium is overdose—absolute or relative. Rapid recovery (<30 minutes) was observed from the effects of suxamethonium when (1) single doses no larger than 3 mg/kg were injected, (2) continuous infusion was limited to 1 hour, or (3) the infusion was intermittent. Prolonged recovery (>30 minutes) was often seen when single doses of 5 mg/kg were given or when suxamethonium was continuously infused for 2 hours. This suggests that the prolonged response was attributable to the large dose given. Since muscle relaxation can be produced by the central nervous system depressant effect of anaesthetics it would seem prudent to combine a light level of anaesthesia with minimal doses of suxamethonium in order to avoid overdose.

In patients sent to the authors because of prolonged postoperative respiratory depression, overdose appeared to be an important factor. These patients who during a previous operation had received the “usual dose” of suxamethonium and experienced prolonged recovery were found to be very sensitive to the drug, requiring for 90 per cent depression of twitch only one-third to one-half the dose they had previously received (Katz, unpublished data). These and other patients may have received larger doses of suxamethonium than necessary because of the use of nitrous oxide without supplementation. In a study in which unsupplemented nitrous oxide was used and in which the majority of patients received 500–600 mg/hr of suxamethonium there was at least a 10 per cent incidence of prolonged recovery from the effects of the relaxant (Frumin, 1957).

Other patients sent for diagnosis were found to be unusually sensitive to suxamethonium because of medications they were receiving, disease, or the presence of atypical pseudocholinesterase (homozygotes or heterozygotes). Although it is well known that a prolonged response to suxamethonium is seen in homozygotes it is less well appreciated that heterozygotes may also be unusually sensitive. Two heterozygotes we have encountered are cases in point. We do not know how many heterozygotes (approximately 3–4 per cent of the population (Kalow and Gunn, 1957)) we may have encountered but not recognized because they did not have an unusual response to suxamethonium. Four of six heterozygotes studied by Kalow and Gunn (1957) had a greater than normal duration of apnoea following suxamethonium. The level of pseudocholinesterase was normal in five of the six, but their dibucaine numbers were abnormal.

CONCLUSIONS

Suxamethonium can be used most safely if (1) the block is constantly monitored with a nerve stimulator and the smallest necessary dose given, (2) a light level of anaesthesia is maintained (such that the patient would lie still during surgery if not paralyzed), and (3) suxamethonium is given only when muscle relaxation is required for the surgical procedure, with periodic discontinuation of administration to allow recovery of neuromuscular transmission. When continuous prolonged relaxation is required tubocurarine is to be preferred.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the aid of Dr. S. H. Ngai.

REFERENCES


**LES EFFETS NEUROMUSCULAIRES DU SUXAMETHONIUM CHEZ L'HOMME**

**SOMMAIRE**

Les effets neuromusculaires du suxamethonium (dose unique et infusion continue) ont été étudiés chez des patients anesthésiés. Une différence notable de la réaction des malades a été remarquée. Le blocage était initialement dépolarisant mais devenait désensibilisant avec la progression du temps et l'augmentation de la dose. Une tachyphylaxie a été observée à doses répétées de suxamethonium, mais pas à l'infusion continue. La profondeur de l'anesthésie constituait un facteur important pour déterminer la dose de suxamethonium nécessaire pour obtenir des conditions opératoires satisfaisantes. Si on infusait le suxamethonium continuellement durant moins d'une heure ou par intermittence durant plusieurs heures, le rétablissement était toujours rapide (3–21 minutes). Mais chez quatre des neuf patients, recevant le suxamethonium en infusion continue durant deux heures, le rétablissement nécessitait 51–69 minutes.

**DIE NEUROMUSKULÆREN WIRKUNGEN VON SUXAMETHONIUM BEIM MENSCHEN**

**ZUSAMMENFASSUNG**