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E.C.T. Phases With and Without Anaesthesia:

A Preliminary Statistical Study

By P. C. TRESISE AND N. S. STENHOUSE

It is well known that there is a definite march of events from onset to ending in the epileptic seizure. The sequence of symptoms differs in the different forms. "Idiopathic" epilepsies have a march through aura, tonus, clonus, and recovery, while Jacksonian organic epilepsies show a characteristic march directly related to their brain anatomical location. Electrically induced therapeutic epilepsy likewise has a march of events which is fairly constant though deviations from the normal pattern do occur, and it is our purpose in what follows to establish and quantitate the normal sequence of events.

In the clinical practice of one of us (P.C.T.), variation in the march of a seizure due to age, sex, electrical dose, and previous medication was apparent. Multivariate regression studies dealing with these factors have been carried out but are omitted here where we are primarily concerned with variation due to adjuvant anaesthesia. Likewise, deviations due to organic neurological diseases have also been observed, but will be separately reported, as here we wish to establish the normal variation first, with a statistical study on the effect of anaesthesia. It will be shown that there is a variable upon which a normal E.C.T. pattern can be conveniently based. The clinical observations indicated that the time to the onset of clonus was the most apt choice.

The electrical dosage and the technique were standard. The machine was manufactured by Both; the potential used was 140 volts, and the current ranged from 80 to 120 milli-amps. Chrome electrodes covered with saline-saturated gauze were applied in the standard bifrontal position and the time range of the stimulus was from 0·3 to 1·0 seconds.

The patients were prepared with maximum reassurance and understanding of the nature of the treatment and why it was being given. Their co-operation and complete relaxation was aimed at and usually obtained. Treatment was given in the supine position. All patients were able *to open their mouths* and hold a clean dry towel between their teeth or gums before the therapeutic stimulus was applied.

The clonus was measured from its onset in the orbicularis oculi muscles to its cessation time when the last clonus spasm was observed.

Amylobarbitone sodium 500 mg. was given to 81 patients; methohexitone sodium ("Brietal") 30 to 50 mg. to 954; thiopentone 150 to 350 mg. to 727; diazepam ("Valium") to 24; and 166 patients were treated without any anaesthesia. Thus there were 1,952 treatments in which a simple electrical dose was given, and there were no neurological or other somatic diseases present.

We divide the electroplexic phases clinically into six:

1. Preparational phase, preceding the electrical dose.
2. Stimulus phase, the time immediately at and after the stimulus dose.
3. Kinetic phase, or time between the stimulus and the tonus state. It has three definite subdivisions, the atonic (following the stimulus), the tonic (similar to decerebrate posture), and then a clearly recognizable pattern of movement, the kinetic stage proper which ends when the march of events has arrived at tonus.
4. Tonus phase, the body assuming its characteristic position of general rigidity.
5. Clonus phase, beginning in the eyes and proceeding through the body.
6. Recovery phase, including transient atony, a brief decerebrate state, the return of respiration to normal regularity, and the recovery of

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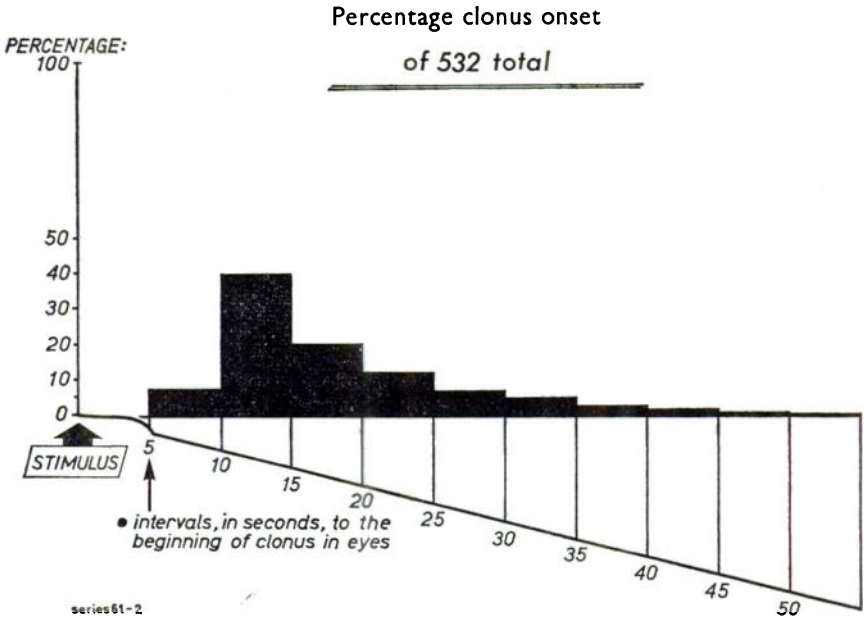


FIG. 1.—The delay between stimulus and onset of clonus in the eyes of 532 patients under thiopentone. The percentage of patients with a delay falling in each five-second group is shown.

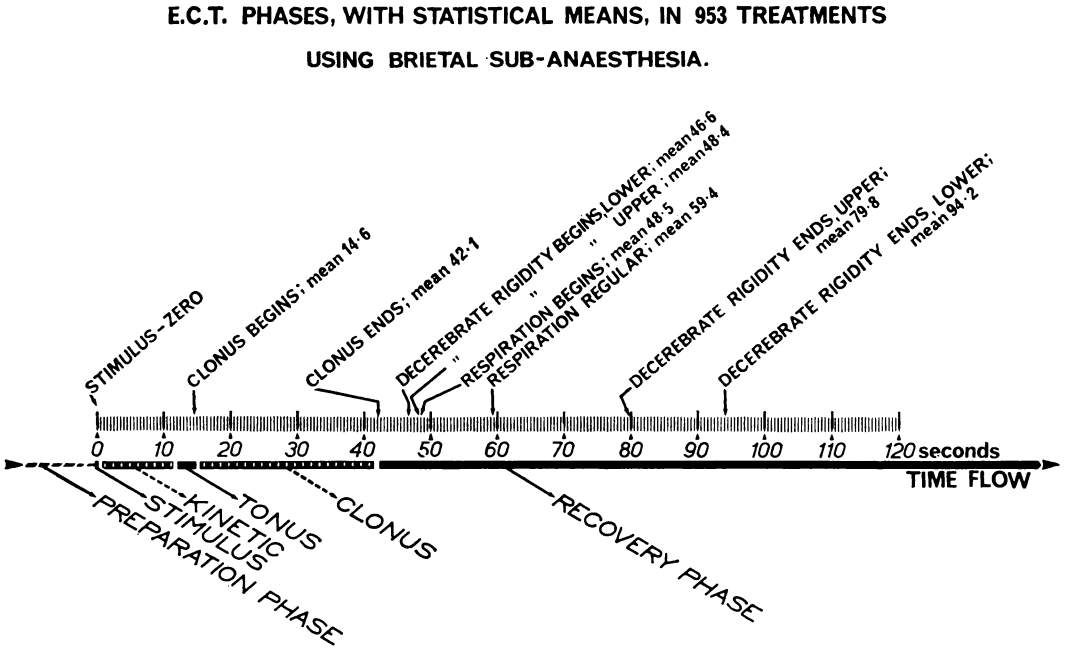


FIG. 2.

Note: The statistical mean times of the events from stimulus zero are marked along a linear time flow in seconds, and the electroplexic phases with their approximate durations are scored below.

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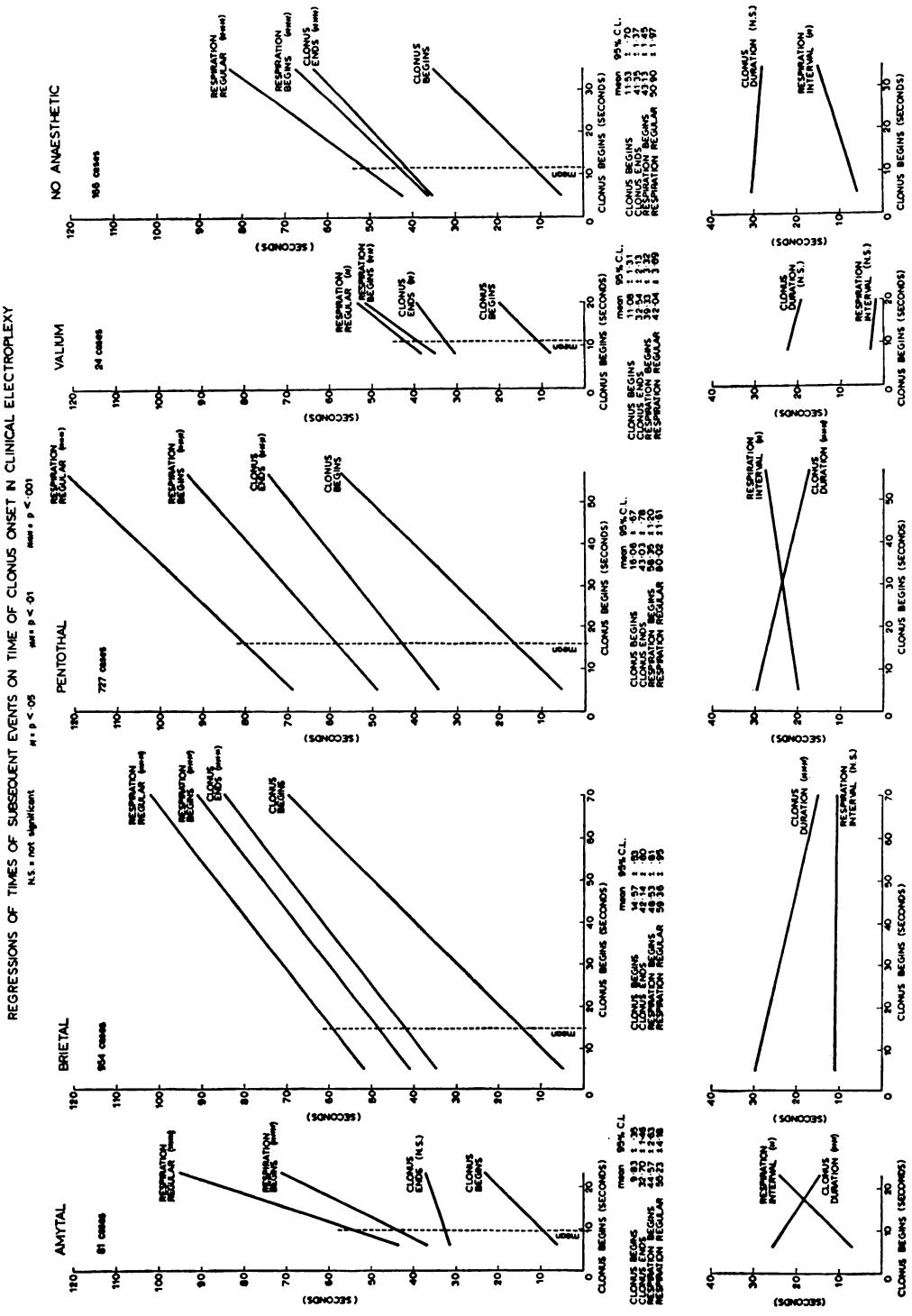


FIG. 3.—Comparative study of the regression of times of the subsequent events on the time of clonus onset in clinical electroplexy with different anaesthetics.

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the patient with full memory at 15 minutes to one to two hours later.

Results

It was observed clinically that there was a considerable delay period between the stimulus and clonus onset in many patients. Fig. 1 is a diagram of the studies made in 1961. It shows the percentage distribution of the delay of clonus onset in a group of 532 patients who were treated with E.C.T. The adjuvant anaesthetic was thiopentone.

It is noticeable that 40 per cent. occur in the class interval of 10 to 15 seconds from the stimulus time. The minimum delay measured was 5 seconds and the maximum was 50 seconds. No instance of the clonus occurring earlier than 5 seconds has ever been recorded.

In Fig. 2 the mean times of occurrence of the sequential events are presented. These statistics were derived from the records of 954 cases in which methohexitone sodium was the adjuvant anaesthetic. Such a large number in the sample ensures that the means are estimated with considerable precision. For example, the 95 per cent. confidence limits of the mean time at which clonus begins are $14 \cdot 57 \pm 0 \cdot 53$ seconds, and those of the delay between the resumption of respiration and the achievement of respiratory regularity are $10 \cdot 83 \pm 0 \cdot 58$ seconds. In Fig. 3 the regressions of clonus ending, respiratory onset and its rhythmicity on the time of clonus onset are presented for each of the four anaesthetics, and for no anaesthesia.

The vertical line at the mean of the onset of clonus in the methohexitone graph passes through the means of clonus ending, respiration onset and its resumed regularity. These means are also well determined being $42 \cdot 14$, $48 \cdot 53$ and $59 \cdot 36$ respectively with their 95 per cent. confidence limits $\pm 0 \cdot 60$, $\pm 0 \cdot 81$ and $\pm 0 \cdot 95$ seconds.

The onset of clonus line is 45 degrees in all the graphs since the regressions are studied from this point. The three regressions of clonus ending and respiratory onset and regularity on clonus onset are highly significant. These lines are almost parallel. In the lower graph the interval between the onset and regularity of respiration is presented and in the case of Brietal may be seen to be virtually constant for all times of clonus onset. The duration of the clonus decreases significantly as clonus onset delay increases and this holds for the other anaesthetics. The respiratory interval, however, rises with amylobarbitone, thiopentone, and with no anaesthetic. The small size of the diazepam sample allows no definite conclusion to be reached here.

From this relatively unsophisticated analysis we are able to make a number of inferences with some certainty. For example the mean time between stimulus and the return of rhythmical breathing is $59 \cdot 4$ seconds with methohexitone sodium and $80 \cdot 0$ seconds when thiopentone is used. The difference of $20 \cdot 6$ seconds is highly significant ($p < \cdot 001$).

Conclusion

The normal response time patterns in E.C.T. with four anaesthetics and without anaesthetic have been established in the cases of the most commonly used agents, thiopentone and with some precision.

The dependence of the times of subsequent events on the time of clonus onset in the orbicularis oculi muscles has also been established.

P. C. Tresise, *Senior Honorary Psychiatrist*
N. S. Stenhouse, *Honorary Bio-Statistician*
Royal Perth Hospital, Perth, Western Australia

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