malaise, and unilateral parotitis. Attempted virus isolation gave negative results. Complement fixation tests, although yielding higher values than expected, showed no rise during convalescence, and thus failed to confirm the clinical diagnosis of mumps made by her father, a physician.

The technique described should prove useful in many phases of clinical investigation of mumps, especially for the detection of virus in bodyfluids and secretions at different stages of the disease and in the presence of various complications. Such studies are now in progress.

Summary. A technique for the direct isolation of mumps virus by inoculation of saliva into the amniotic sac of chick embryos is presented in detail. Employing this technique, mumps virus was isolated from 8 of 9 patients with clinical mumps.

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Electroencephalogram of Cats Subjected to Repeated Minimal Convulsive Doses of Electricity.

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In a previous study it was shown that the cat could survive a surprisingly large number of repeated convulsions when these were induced by minimal convulsive doses (MCD) of electricity.[1] In the course of such studies it became of interest to determine what electroencephalographic (EEG) alterations took place, especially since the gross behavioral changes of the animals were not particularly striking. A number of other investigators have already described the EEG in several species of normal animals—*e. g.* cat, dog, rabbit and monkey. Reports concerning the brain wave activity following electrically-induced convulsions, however, are relatively meager[2-6] and no data has so far been made available depicting the EEG changes in animals as their convulsions were continued.

It is, therefore, the purpose of this communication to report such a study in which the progressive changes in the electroencephalogram of cats subjected to frequently repeated convulsions were observed.

For this purpose 12 adult cats were subjected to repeated electrically-induced convulsions at approximately 5 minute intervals with minimal convulsive doses of electricity (alternating current). Solder electrodes were applied 20 mm cephalad to the external occipital protuberance and 10 mm from the midline on each side of the head which corresponded to bilaterally homologous areas of the underlying occipital lobes. These electrodes were held in contact with the shaved scalp previously treated with electrode paste (Sanborn) by the aid of parlodion and were led into the Garceau electroencephalograph. All animals were kept in a shielded box during recordings.

Results. Of the 12 cats employed, 7 succumbed and 5 survived. Because the electroencephalographic patterns were essentially similar in all animals the results obtained can best be represented by the following three plates.

[1] Rubinstein, H. S., and Kurland, A. A., in press.

[2] Lowenbach, H., and Lyman, R. S., *J. Neurol. and Psychiat.*, 1940, **3**, 336.

[3] Bawera, S. E., Lewis, N. D. C., Pacella, B. L., and Kalinowsky, L., *Tr. Am. Neuro. Assn.*, 1942, **68**, 31.

[4] Rheinberger, M. B., and Jasper, H. H., *Am. J. Physiol.*, 1937, **119**, 186.

[5] Clark, S. L., Chambers, W., and Baker, C. F., *Anat. Rec.*, 1942, **82**, 482.

[6] Clark, S. L., and Ward, J. W., *J. Neurophysiol.*, 1945, **8**, 99.

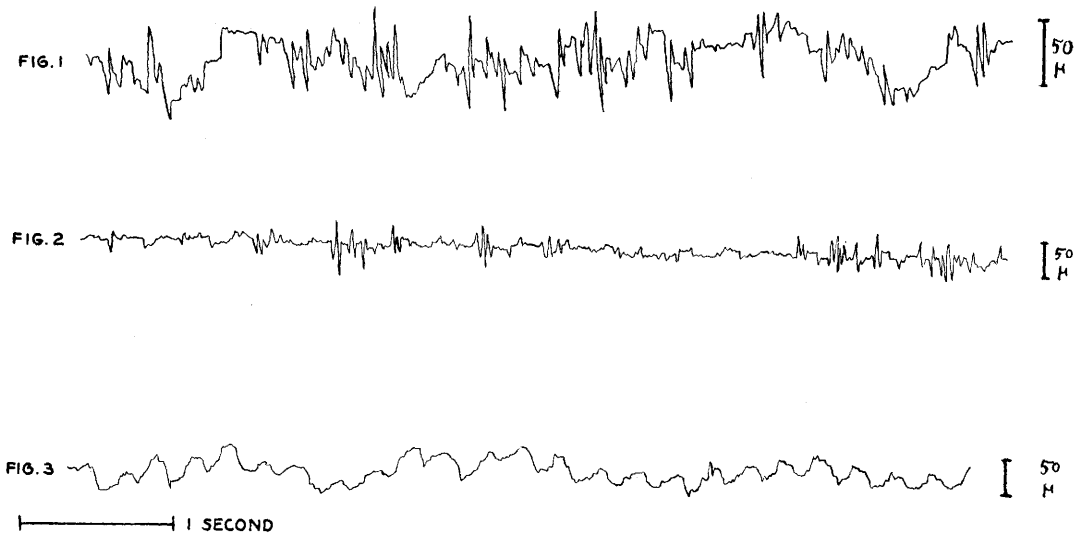

PLATE I (CAT NO. 15)

Fig. 1. Normal tracing with animal somewhat tense disclosing a 14 per second medium voltage pattern interspersed by occasional high voltage slow waves.

Fig. 2. Tracing obtained following the 24th convulsion some 2 hours and 15 minutes after the first convulsion. Only occasional bursts of 14 per second medium voltage waves are seen, the predominating pattern consisting of 9 per second medium and low voltage waves.

Fig. 3. Tracing following the 52nd convulsion 4 hours after the first convulsion. Four per second, medium and low voltage waves are dominant. The cat died 2 hours later following its 64th convulsion.

Plate 1—discloses a typical record (of cat no. 15; wt. 5¼ lbs.) through 4 hours of electro-shock convulsions.

Plate 2—discloses a more detailed electroencephalogram taken at 1 hour intervals on a cat (4¼ lbs) which finally succumbed to repeated electro-shock convulsions.

Plate 3—is a record taken from a cat (no. 23) weighing 5 lb. which survived 95 convulsions over a period of 8 hours.

Discussion. It will be observed that 2 distinct brain wave patterns may be considered normal for the adult cat. The one is the 8 to 12 per second medium voltage rhythm in the relaxed cat; the other is the more rapid (usually 14 to 21 per second) medium voltage rhythm in the tense animal (plate 2, Fig. 1). Since the degree of tenseness and alertness usually go together one may infer that the more rapid pattern is indicative of increased alertness.

Animals subjected to repeated electrically-induced convulsions disclose a rather characteristic change in the electroencephalogram. First, the *frequency gradually decreases and the voltage gradually increases.* This continues until continuous slow *high voltage waves* replace the normal pattern. As the experiment continues the slow waves persist but the voltage begins to diminish. As the experiment is pushed the low voltage becomes fixed but a *temporary rise in frequency* (to a normal 9 per sec.) may be seen. Finally, the voltage approaches zero and the *waves become ill-defined* as death approaches.

This seems to indicate that repeated convulsions lead to a gradual depression of cerebral cortical irritability only to be interrupted by a short-lived rise in excitability shortly before death ensues. This presumed increase in cerebral cortical "apathy" seems to be substantiated by the observation that the convulsive threshold rises as the experiment progresses.[1] This study also shows the surprising degree of recovery in the cat in the brief space of 3 weeks after as many as 95

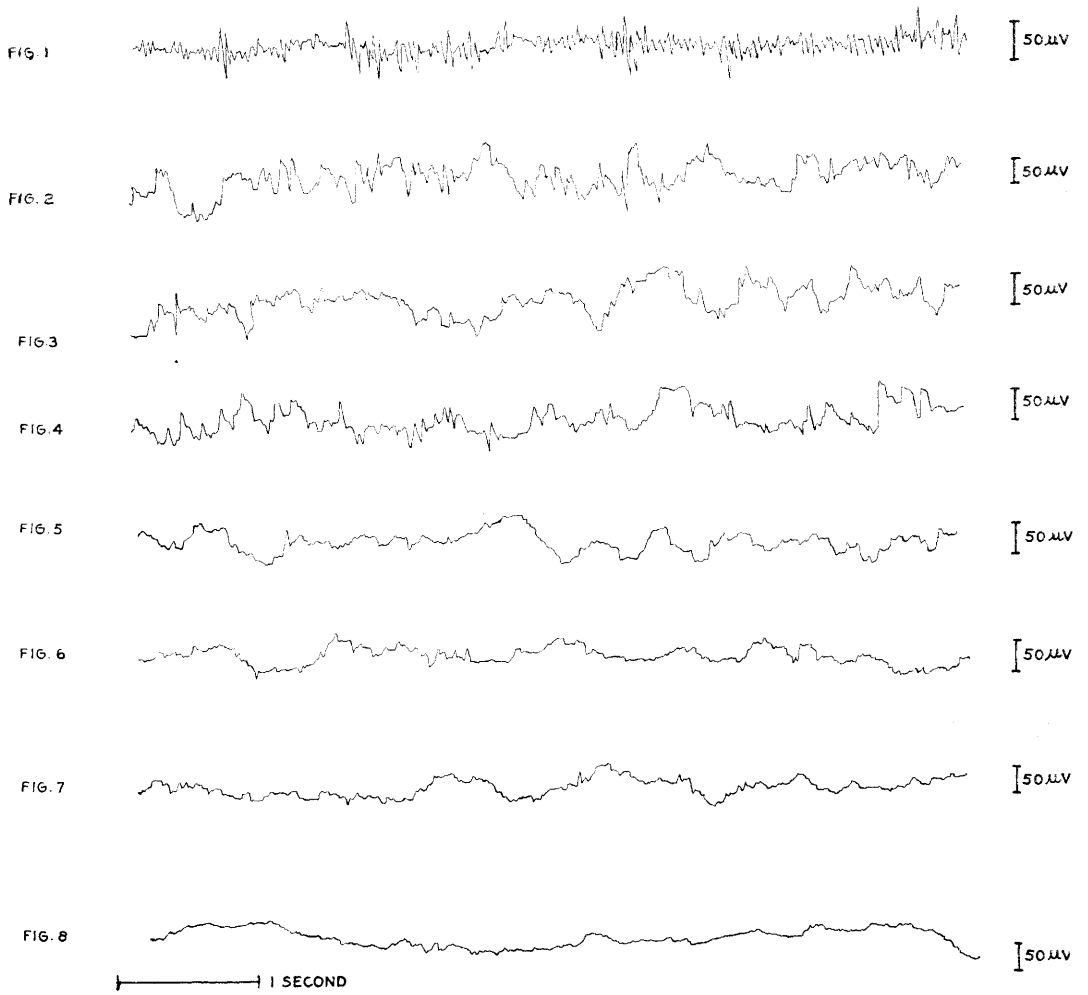

PLATE 2 (CAT NO. 16)

Fig. 1. Control tracing; animal is tense; 21 per second *medium voltage* rhythm.

Fig. 2. Tracing obtained after 10th convulsion (1 hour after beginning of experiment). Nine per second medium voltage rhythm interspersed with fairly frequent slow (2-4/sec.) *high voltage waves.*

Fig. 3. Following 18th convulsion (2 hr after onset) 8-10 per second medium and low voltage rhythm interspersed with more frequent slow high voltage waves.

Fig. 4. Following 28th convulsion (3 hr after onset) a 7 per second high voltage rhythm interspersed with short runs of 9 per second low voltage waves.

Fig. 5. Following the 36th convulsion (4 hr after onset) continuous slow wave activity of low, medium and high voltage.

Fig. 6. Following the 42nd convulsion (5 hr after onset) continuous low voltage waves varying from 4 to 8 per second.

Fig. 7. Following the 60th convulsion (7 hr after onset) continuous low voltage of 8-9 per second frequency interspersed by an occasional slow medium voltage wave.

Fig. 8. Following the 70th convulsion (8 hr after onset). Shifting base line with extremely low voltage with occasional ill-defined 2-4 per second waves. The animal died 25 minutes later.

convulsions. Recovery has also been observed in the convulsion-induced abnormalities of the human EEG. The human receiving electro-shock therapy, however, is never subjected to the concentration of treatment to which these experimental animals were ex-

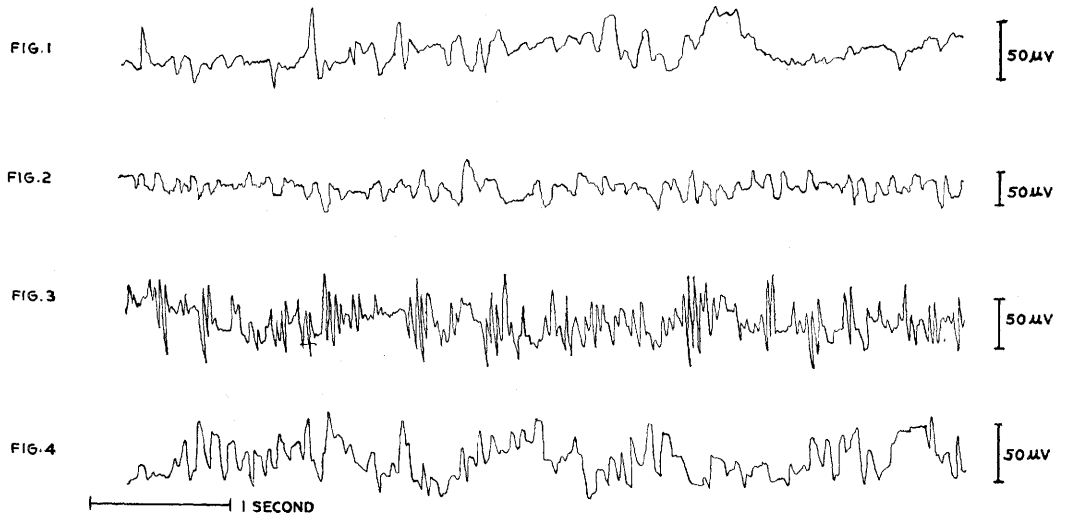

PLATE 3 (CAT NO. 23)

Fig. 1. Tracing obtained 7 days after the last convulsion when the cat was relaxed. The 7 per second medium voltage rhythm is interspersed by occasional higher voltage notched waves.

Fig. 2. 18 days after the last convulsion taken when cat was relaxed showing 8 per second medium voltage waves interspersed by an occasional 5-6 per second high voltage wave.

Fig. 3. Tracing obtained on the same day of tracing immediately above when the cat was tense. Thirteen per second medium voltage waves interspersed by an occasional slow high voltage wave.

Fig. 4. 21 days after the last convulsion taken when cat was relaxed showing an 8-10 per second medium voltage rhythm interspersed by an occasional slow high voltage wave.

posed. Even so, the disappearance of abnormalities in the human is a much slower process so that months may elapse before normal records are obtained. Kalinowsky and Hoch[7] reviewing this subject find that in the human as few as 6 convulsions (usually administered over as many or more days) will lead to slow high voltage waves which may require 1 to 5 weeks for recovery. In patients receiving 7 to 12 convulsions the recovery process may extend from 1 to 3 months. When more than 12 treatments are given recovery may require 2 to 6 months.

More rapid recovery occurs in the monkey[3] but in these animals, too, the treatment was given in relatively non-concentrated dosage.

Considering the intensity of the treatment administered to the cat (in these experiments) the rapidity of recovery (21 days after 95 convulsions) is truly amazing. This was best exemplified by the gross behavior of the surviving cats. In such animals hopping and placing reactions, gait, feeding habits, preening and general alertness recovered to a degree which was indistinguishable from the untreated control cat.

Summary and Conclusion. Electroencephalographic studies were carried out in a series of 12 adult cats subjected to minimal convulsive doses of electricity repeated at approximately 5 minute intervals. It was observed that the 8 to 12 per second medium voltage rhythm of the normal relaxed cat and the 14 to 21 per second medium voltage rhythm of the normal tense cat were gradually and successively replaced by decreased frequency, lowering of voltage, continuous slow high voltage waves, fixed low voltage, temporary 9 per second (but still low voltage) waves and decreasing voltage to zero as death approaches. In the cat surviving as many as 95 convulsions the recovery of the altered electroencephalogram occurred 21 days after the last convulsion.

[7] Kalinowsky, L. B., and Hoch, P. H., Shock Treatments and other Somatic Procedures in Psychiatry, Grune and Stratton, N. Y., 1946.