ANY QUESTIONS?

We publish below a selection of questions and answers of general interest.

Vaccine for Salmonella Carriers

Q.—Has any work been done on curing salmonella carriers with a course of graduated doses of vaccine containing the same O antigen as the infecting salmonella?

A.—There was a time when vaccines were tried for almost anything, and this purpose is no exception. For information about this and many other unsuccessful methods for clearing typhoid carriers the questioner should consult the monograph by C. H. Browning.¹ He quotes a statement made by Ledingham and Arkwright in 1912: "The treatment of intestinal carriers by typhoid vaccines has,

it must be confessed, been unsuccessful or indecisive," and he adds similarly negative personal observations in which vaccines prepared in various ways were given either by injection in numerous large doses or orally.

It may be assumed that what is true of *S. typhi* would apply to other salmonellas. Even were it possible entirely to rid the tissues of organisms by active immunization, those free in the biliary and intestinal tracts could presumably not be much affected.

REFERENCE

¹ Browning, C. H., *Medical Research Council Special Report*, 1933, No. 179.

Child Development in Tropics

Q.—Is there any evidence to support the statement that children mature more quickly in a tropical environment?

A.—There is no evidence to support the statement. On the contrary, menarchial age—that is, age at first menstruation—in tropical countries shows maturation to be usually slower there than in temperate climates. This, however, is probably owing to the lower level of nutrition usually prevailing in tropical zones.¹

REFERENCE

¹ Tanner, J. M., *Growth at Adolescence*, 1962, 2nd ed. Oxford, Blackwell Scientific Publications.

NEW APPLIANCES

Device for Continuous Monitoring of Cerebral Activity in Resuscitated Patients

Mr. D. MAYNARD, Dr. PAMELA F. PRIOR, and Dr. D. F. SCOTT, E.E.G. Department, London Hospital, London E.1, write: Patients who have been resuscitated after cardiorespiratory arrest often pose a problem regarding the likelihood of survival and the quality of life possible. Brain damage may have been sustained during the arrest, and this can be difficult to assess in the unconscious patient. Accurate diagnosis of irreversible brain damage or "brain death" is of the utmost importance now that transplant surgery, using human donors, is becoming more common, and the electroencephalogram (E.E.G.) has proved to be of value in assessing the probability of survival (Hockaday *et al.*, 1965; *British Medical Journal*, 1968; Pampiglione and Harden, 1968; Prior and Volavka, 1968). The conventional E.E.G., however, has limitations because it requires continuous operation by highly skilled personnel and involves complex and bulky equipment producing a lengthy paper trace. Consequently it is too expensive and intricate for use in routine monitoring (see Feldman and Ellis, 1967). The E.E.G. is thus suitable only for intermittent use and is not a practical proposition for the long-term assessment that many patients in an intensive care unit require. To obtain this continuous assessment we have used, in combination with conventional E.E.G. examinations, a simple device called the cerebral function monitor.

GENERAL PRINCIPLES

The cerebral function monitor consists of a system in which the E.E.G. signal from a single pair of electrodes is amplified and passed through a special wide-band filter. The signal is then subjected to logarithmic amplitude compression and passed into a peak sensitive rectifier. This has a short time constant so that it will follow short-term fluctuations of the amplitude of the activity. The output is displayed on a meter and on one trace of a slow-speed chart recorder (5 cm./hour), the level and width of the trace being a function of the type of E.E.G. Because the recording electrodes remain in place for long periods

it is necessary to have some method of monitoring their state of conductivity. Consequently a special network which continually monitors electrode impedance has been added in parallel with part of the cerebral function monitoring system. The output of the impedance monitor is fed to a separate trace of the chart recorder. In this way it can be seen when an electrode contact has begun to deteriorate, so that advance warning is received that it will need replacing; similarly, an indication is given when an electrode artifact has occurred. Blocking or malfunctioning of the amplifier is also indicated by large excursions below the zero impedance line. A diagram of the apparatus is given in Fig. 1.

ELECTRODES

The electrodes used are of the conventional silver/silver-chloride stick-on E.E.G. type and usually require reapplication every two to three days. Electrode jelly needs to be added every 12 to 24 hours. Their leads and the cable connecting them to the amplifier are fully screened with non-microphonic coaxial cable, so that pick-up from adjacent leads or other apparatus and artifacts arising from movements of leads are practically eliminated. The two recording electrodes are electrically isolated from earth. They

are placed transversely 2 in. (5 cm.) apart and about 2 in. posterior to the vertex. This derivation is least likely to be affected by muscle artifact. There is an optional earth electrode which may be omitted if it is felt that this may be prejudicial to the requirements of electrical safety. Omission of this electrode, however, may cause some degradation of the in-phase rejection ratio of the amplifier at high electrode impedances of the order of 25 Kohms; the normal electrode impedance is of the order of 3 Kohms. In order to minimize mechanical strain on the electrodes their leads are attached to the patient in any convenient manner which does not interfere with nursing procedures.

CEREBRAL FUNCTION MONITOR

A radio-frequency trap precedes the E.E.G. amplifier. This was found to be necessary to eliminate interference from static electricity generated by articles of clothing. The amplifier is of the parametric type having an input impedance of 10 Mohms with an in-phase rejection ratio in excess of 110 dB. The characteristic of the filter used is indicated in Fig. 1. It cuts off sharply below 2 c.p.s., to reject factors such as the low-frequency fluctuations caused by sweating, and even more sharply above 15 c.p.s., with a high degree of rejection at 50 c.p.s. This rejection is necessary

Fig. 1.—Block diagram of cerebral function monitor including impedance monitor.

because mains interference is not always exactly in-phase at the recording electrodes. The slope of the filter in the pass band is approximately the inverse of that of a normal E.E.G. at a moment when no alpha or beta rhythms are occurring. Its effect is to flatten the frequency spectrum of the E.E.G. within the pass band, enabling a more stable measurement of the level of the non-sinusoidal components to be made during those periods when sinusoidal activity is not present.

After filtering, the signal is passed through a semilogarithmic amplitude compression network. This is necessary because of the large fluctuations of level of the E.E.G., and it also enables the instrument to be operated without any need for gain adjustments. After peak-to-peak rectification the output is effectively the smooth line drawn through the peaks of the compressed signal with the D.C. component retained. If this output is written out on a slow-speed chart recorder using a heat-sensitive paper the band of activity can be made to have a variable intensity corresponding to the amplitude distribution of the signal.

IMPEDANCE MONITOR

The impedance monitoring network injects a high-frequency signal across the electrodes via 70-Mohm resistors and small isolating capacitors. The variations of electrode impedance together with the capacitance of the phase of the signal relative to its source. After passing through the parametric E.E.G. amplifier the signal is extracted from the E.E.G. and its phase compared with the source. The phase change is a function of the electrode impedance. The internal logic of this network is connected so that if, for zero impedance, the output is zero, then the output for increasing impedance moves positively. If, however, the signal from the E.E.G. amplifier is removed by amplifier block or failure, the output moves negatively. Consequently the continuous recording of this output is a record of both the electrode and the amplifier states.

The only control provided with this apparatus is the on/off switch. Consequently, once the electrodes have been applied the apparatus does not require skilled operation.

Examples of the clinical use of this apparatus are given in Figs. 2, 3, and 4.

CONCLUSION

It can be seen from these examples that an apparatus for continuous monitoring of brain function as provided by the cerebral function monitor is a useful adjunct to intermittent conventional E.E.G. recordings in resuscitated patients with suspected brain damage.

Continuous monitoring indicates whether cerebral activity is increasing, decreasing, or remains the same, and also shows whether or not conventional E.E.G. samples are typical of the on-going activity. The cerebral function monitor is therefore a valuable aid to the clinician in making decisions about treatment.

Patents have been applied for and the rights assigned to the National Research Development Corporation.

We are grateful to the staff of the London Hospital for permission to examine their patients.

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Fig. 2.—Cerebral function monitor tracing from a deeply comatose man who had an isoelectric E.E.G. after cardiac arrest. The constant near zero level on the cerebral function monitor gave a far greater confidence in the clinical diagnosis of gross brain damage than was possible with daily intermittent E.E.G.s alone. It should be noted that though the E.E.G. was described as isoelectric the cerebral function monitor tracing is not on the baseline. Much of the tracing is below the noise level of most E.E.G. recorders. The impedance tracing shows an electrode artifact when the patient was turned.

Fig. 3.—Cerebral function monitor tracing from a semi-conscious woman three days after a cardiac arrest. The tracing shows a sudden drop to a lower level, and it was found that her blood pressure had fallen. There followed a trend downwards until a final cardiac arrest occurred, when activity fell to zero.

Fig. 4.—Cerebral function monitor tracing from a woman unconscious after barbiturate overdose. The conventional E.E.G. taken just before this tracing was begun showed bursts of activity separated by isoelectric periods. This corresponds to the low-level broad-band activity of the first part of this tracing up to about 13.45 hours. The subsequent rise and narrowing of the trace showed a return to continuous cerebral activity, which became increasingly normal in appearance over the next few days. This evidence of a likely recovery preceded by many hours any clinical response to stimuli or the return of spontaneous respiration.