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THE PROGNOSIS OF SURVIVAL FROM CEREBROVASCULAR ACCIDENTS

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No longer can a physician remain passive towards a patient who has presented with a cerebrovascular accident, for an intracerebral haematoma is now an operable condition. Moreover a haematoma may be a more common cause of slowly attacking strokes than has been previously thought. Arteriography, which is often a diagnostic necessity, and operation itself, however, are not without risk (Baker, 1960; Bull, Marshall, and Shaw, 1960; McDowell, Schick, Frederick, and Dunbar, 1959; Sedzimir, 1960). The clinician is, therefore, faced with the problem of advising these procedures in patients who are not dying but may die as a result of them.

Were it possible to predict death or survival in the early stages of a cerebrovascular accident, this problem would be solved, for, if it is confidently predicted that a patient is going to die, the physician is free to do nothing or to carry out any treatment no matter how heroic. On the other hand, if it is predicted with confidence that a patient will survive, then the physician must be sure that any potentially dangerous investigation or operation, now no longer excusable as life-saving, must offer substantial benefit in terms of reduction of ultimate disability.

The purpose of our investigation was to discover early clinical and E.E.G. evidence which would allow confident predictions of life and death in cerebrovascular accidents. As far as we are aware, such predictions are not possible on the basis of present knowledge.

Material

The patients in our series were confined to those who were seen during 1960 and who were examined within seven days of the onset of the stroke. The total number of patients examined was 96 but six were excluded because they were considered to have brain-stem lesions. The series, in fact, contains only those patients who were thought to have cerebral infarctions or intracerebral haematoma. A further five patients were excluded since they had convulsions, on the grounds that such seizures may produce alterations in consciousness and also muscular weakness. Such postictal features confuse the clinical picture of a stroke and of course produce E.E.G. abnormalities which are not directly relevant to the cerebrovascular accident itself. The series to be reported, therefore, consists of 85 patients.

The age distribution of the patients was as follows.

Decade	4th	5th	6th	7th	8th	9th
Number	2	14	23	28	14	4

The time intervals between the onset of the strokes and our examinations were as follows.

	Days						
Interval	Under 1	1-2	2-3	3-4	4-5	5-6	6-7
Number	39	19	5	12	3	3	4

Methods

Each patient had a detailed neurological examination and 79 had an E.E.G. Twenty-five patients had the cerebrospinal fluid examined, six had neurosurgical operations, and 31 of the 43 fatal cases had necropsies. In the clinical examination particular attention was paid to the level of consciousness and to the severity of the hemiplegia.

The grading of the level of consciousness is one commonly used and is shown in Table I. Most patients were not seen within 12 hours of the onset of the stroke and it follows that all the gradings of conscious levels given in our results refer to examinations made after 12 hours. A few patients who were seen under 12 hours were not

TABLE I

GRADING OF CONSCIOUS LEVELS

Grade of Consciousness	Clinical Assesment
1	No response to any stimulus
2	Response to painful stimulus only
3	If aphasic, performs simple acts spontaneously, *e.g.*, feeding, adjusting blankets, or simple imitative movements If not aphasic, obeys simple commands, *e.g.*, closing eyes, raising hand
4	If aphasic, performs complex acts spontaneously, *e.g.*, personal toilet, or complex imitative movements as in neurological examination If not aphasic, obeys complex commands as in a neurological examination

graded until a 12-hour period had elapsed, unless death occurred before this. No patients, as far as we could judge, deteriorated in their conscious level from 3 to 2 (a critical change as will later be seen) between the onset and the time of our examination. Hence, conscious level 1 or 2 in the tables of results implies a persistence of these levels for at least 12 hours, unless, of course, death supervened. However, on the basis of observations by general practitioners and house physicians, several patients evidently improved from conscious levels 1 or 2 to levels 3 or 4 before we saw them. Again as far as we could judge, the duration of levels 1 and 2 was short, usually an hour or so and certainly well within the period of 12 hours.

In the assessment of hemiplegia we distinguished between (*a*) a hemiplegia consisting of complete paralysis of all parts on one side and (*b*) a hemiplegia consisting of either complete paralysis of some parts or of incomplete paralysis of all parts on one side. Henceforth type (*a*) will be called a total hemiplegia and type (*b*) a partial hemiplegia. No attempt was made to grade the hemiplegia in patients who had a conscious level of 1 or 2.

Electroencephalograms were recorded immediately after the clinical examination on either an eight-channel Ediswan or a portable Offner apparatus. Most of the recordings were taken with the latter at the bedside. Bipolar electrodes were used.

The severity of the E.E.G. abnormalities was at first graded as gross, moderate, or slight. The slight abnormalities were those which are occasionally found in normal people, whereas the other abnormalities were outside normal limits. To simplify the tables grossly and moderately abnormal records were grouped together and called grossly abnormal. The slightly abnormal records were grouped with the normal records. Grossly abnormal records were divided into those which showed bilateral abnormalities and those in which the abnormalities were confined to one side.

Some E.E.G.s showed a loss of activity in parts of the cerebrum but this feature was ignored in favour of high-voltage slow waves. In two patients, however, a total loss of activity, which was clearly related to their moribund state, was considered to be grossly abnormal.

Results

The mortality rate for the series was 52%. All deaths were considered to be attributable to the strokes. Diagnosis was verified in 45 of the 85 cases and Table II shows the distribution of the various pathologies and mortality. An arteriogram showing a blocked vessel was taken to be diagnostic of a cerebral infarction. Infarction, however, was not diagnosed in patients with normal arteriograms since a normal arteriogram may equally well be found with an intracerebral haematoma (Bull *et al.*, 1960; McKissock, Richardson, and Walsh, 1959). In the presence of a normal arteriogram, therefore, the diagnosis was left open.

TABLE II

CORRELATION OF PATHOLOGY AND MORTALITY

	Verified Haematoma	Infarction (Thrombosis)	Infarction (Embolism)	Diagnosis Uncertain
Alive	2	4	4	32
Dead	14	17	4	8

Relation of Mortality to Conscious Level and Severity of Hemiplegia.—Table III shows a mortality of nearly 100% in patients who presented with conscious levels 1 and 2 persisting for at least 12 hours. The survivor in this group was a woman who was operated on four days after the development of a slow-onset hemiplegia. By the time she was seen she was moribund, but evacuation of a large intracerebral haematoma was followed by marked improvement, leaving her eventually with only a speech deficit. With conscious level 3 survival and death occurred in nearly equal numbers. With conscious level 4 there was no mortality.

TABLE III

CORRELATION OF MORTALITY, CONSCIOUS LEVEL, AND SEVERITY OF HEMIPLEGIA

Conscious Levels	1 and 2	3		4	
Severity of Hemiplegia		Total	Partial	Total	Partial
Alive	1	5	8	2	26
Dead	28	10	5	nil	nil

Severity of hemiplegia was not measured in patients with conscious levels 1 and 2. At conscious level 4 all patients survived irrespective of the severity of the hemiplegia. At conscious level 3, however, total hemiplegia carried a 67% mortality and partial hemiplegia a 38% mortality.

Relation of Mortality to E.E.G.s.—Of the 85 patients, 79 had E.E.G.s. Table IV shows that the occurrence of bilateral gross abnormalities was associated with a mortality of 90% whereas the mortality with any other kind of E.E.G. was only 5% and with a normal E.E.G. it was nil.

TABLE IV

CORRELATION OF MORTALITY AND E.E.G.

	Grossly Abnormal E.E.G.		Normal E.E.G.
	Bilateral	Unilateral	
Alive	4	21	15
Dead	37	2	—

Relation of Mortality to Clinical State and E.E.G.—Table V correlates conscious levels 1, 2, and 4, E.E.G.s, and mortality.

At conscious levels 1 and 2 bilateral gross E.E.G. abnormalities were related to death in all patients except one who has already been mentioned. Two

TABLE V

CORRELATION OF MORTALITY, CONSCIOUS LEVELS 1, 2, AND 4, AND E.E.G.

E.E.G.	Conscious Levels			
	1 and 2		4	
	Alive	Dead	Alive	Dead
Bilateral gross	1	23	—	—
Unilateral gross	—	1	13	—
Normal	—	1	13	—
No E.E.G.	—	3	2	—

patients in this group did not have these gross abnormalities.

At conscious level 4, on the other hand, no patient had bilateral gross abnormalities and all the E.E.G.s showed either unilateral gross abnormalities or no abnormalities.

Table VI shows the correlation between total and partial hemiplegia at conscious level 3, mortality, and E.E.G.s. With regard to cases of total hemiplegia, eight out of 10 showing bilateral gross

TABLE VI

CORRELATION OF MORTALITY AND SEVERITY OF HEMIPLEGIA WITH CONSCIOUS LEVEL 3 AND E.E.G.

	Severity of Hemiplegia			
	Total		Partial	
E.E.G.	Alive	Dead	Alive	Dead
Bilateral gross	2	8	1	5
Unilateral gross	3	1*	5	—
Normal	—	—	2	—
No E.E.G.	—	1	—	—

*At necropsy on this patient, who had a hemiplegia and aphasia no cerebral abnormality was found.

abnormalities died. Of four patients with unilateral E.E.G. abnormalities (there were no normal E.E.G.s), only one died. The E.E.G., therefore divided this group, previously seen to have a mortality rate of 67% (Table III), into two subgroups one of which had a relatively high mortality rate of 80% and the other a relatively low mortality rate of 25%.

With regard to cases of partial hemiplegia, five out of six with bilateral gross abnormalities died, whereas five with unilateral abnormalities and two with normal E.E.G.s all survived. Table III showed that the mortality rate of this group was 38% but the E.E.G. is now seen to divide the group into two subgroups, one of which had a relatively high mortality rate of 83% and the other which had no mortality.

Discussion

It is clear from the results that a confident prediction of life and death can be made from conscious levels 4 and 1 and 2 respectively, provided the last two persist for at least 12 hours. Although the E.E.G. correlates well with the prognosis it is obviously superfluous as a prognostic aid unless the physician has some doubt about the level of consciousness. With conscious level 3, however, the situation is rather different. Even with the additional information of the severity of the hemiplegia, the predictions of life and death are not sufficiently accurate for clinical purposes. It is here that the E.E.G. proves useful, for a distinction between bilateral gross abnormalities on the one hand and other kinds of E.E.G.s on the other allows highly accurate predictions of death and survival respectively. It may be derived from Table VI that 81% of patients with bilateral gross abnormalities died while 91% of patients with other kinds of E.E.G. survived. It is worth noting that the three survivors, who presented with conscious level 3 and had bilateral gross abnormalities, have remained totally and permanently disabled. A bilateral gross E.E.G. abnormality, therefore, in any patient is an ominous sign.

An important feature of this work is that the predictions were based on clinical and E.E.G. observations and did not depend on the pathology of the cerebrovascular lesions. We admit that many patients with minor strokes can never be confidently diagnosed as suffering from an infarction or haematoma but it does not follow that the immediate prognosis of life and death need be difficult.

Turning to the management of patients with cerebrovascular accidents, we submit that, with respect to those who are doomed, there is no reason for withholding vigorous investigation and treatment since a single survival represents a therapeutic triumph. Such investigations and treatment as arteriogram, ventriculogram, burr holes with needling of the brain, tracheotomy, control of fluid balance and anticoagulants, when indicated, should be undertaken at the earliest possible moment after the onset of the stroke.

The management of patients, whose survival is predicted, requires very careful judgment. The choice lies between making no investigations and pursuing investigations which are potentially disabling, frequently uninformative, and sometimes lethal. Were it possible to predict the degree of the ultimate permanent disability in these survivors the choice might be an easier one. Unfortunately such predictions cannot yet be made, at least with any degree of confidence.

The results of our investigation are not of a kind which bring immediate benefit to the patient or make the physicians' decisions any easier. Indeed, as we have indicated the decisions are made more difficult. Nevertheless, observations on the natural

evolution of cerebrovascular accidents must be accumulated if the assessment of therapy, old and new, is to be given a scientific basis.

Summary

The investigation is reported of 85 patients with either cerebral infarction or intracerebral haematoma studied clinically and by E.E.G. The purpose was to discover evidence which would allow the immediate prognosis for life or death.

It was found that patients fell into three groups: those deeply unconscious who had 100% mortality when treated along orthodox lines; those whose consciousness was not impaired and who invariably survived; and those in an intermediate state of consciousness whose outcome could not be predicted accurately on the basis of conscious level alone. Assessment of the severity of hemiplegia in this group improved the accuracy of prediction to some degree.

The E.E.G was used to divide the last group into two subgroups, one having a high and the other a low mortality.

The implications of this study are clear. Patients who are going to die merit vigorous investigation and treatment. Patients expected to survive must not be exposed injudiciously to possibly dangerous procedures.

Addendum

Since this paper was written, McKissock, Richardson, and Taylor (1961) have indicated in their study of primary intracerebral haemorrhage the prognostic significance of deep unconsciousness 24 hours after onset.

Our findings are in agreement, but in addition, we have found that similar criteria can be applied to cerebral infarction.

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