Unusual EEG patterns in coma, and their evolution

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SUMMARY A 23-year-old chronic asthmatic patient is reported who showed successively four different EEG patterns within a 7 day period of unconsciousness following cardio-respiratory arrest. The initial record was dominated by alpha activity, then beta activity supervened, to be followed by spindle components. Finally an isoelectric tracing occurred before death. A computer file search for all cases of unusual EEG coma patterns was carried out. It failed to reveal any other patient with a similar sequence, but various types of evolution were noted. Such features are seen in only a very small percentage of comatose patients, and in the context of cardio-respiratory arrest are almost invariably fatal.

It is well recognised that a discrepancy may be observed between the EEG and the clinical state in comatose patients, an example of which is a tracing dominated by unresponsive alpha activity. This, and its prognostic significance has recently been reviewed in detail.¹ However, deep coma with apparent sleep spindles or with dominant beta components is also observed but has received little attention in the literature. Further, the incidence, aetiology and evolution of these patterns and their prognosis is not well documented. The present report is of a young asthmatic patient in deep coma, whose EEG showed successively within a 7 day period alpha, beta, and spindle activity and finally an isoelectric tracing before demise. In view of this unexpected sequence it was decided to search the clinical neurophysiology department's computer file² to locate all patients who showed unusual coma patterns, with particular reference to their rate of occurrence and evolution as well as their cause. The case report of the asthmatic patient and the results of this search will be given, and the prognostic implications discussed.

Case report

The patient, a woman aged 26 years had a history of bronchial asthma for 17 years. For much of this time she had been steroid dependent, with doses of prednisolone varying from

10 to 20 mg. Five months prior to her terminal admission she developed a right sided pneumothorax, on several occasions responding to the use of a chest drain. However she was admitted to hospital for surgical treatment to prevent recurrence. Her medication was aminophylline 225 mg and prednisolone 10 mg daily. A few days before surgery she became markedly distressed about a family problem. At that stage her lung was fully expanded, but on the day before the planned operation she, without warning, had a cardio-respiratory arrest. In spite of resuscitation and ventilation the patient remained unconscious. Severe broncho-spasm was noted. She was given aminophylline, atropine, isoprenaline and calcium gluconate. Her cardiac output returned to normal after the administration of manitol and dexamethasone, but the state of consciousness failed to improve. A salbutamol infusion was commenced and medication remained essentially unchanged during the period until her demise 7 days later. Throughout this time there was no behavioural evidence of CNS activity. No spontaneous movements of any sort occurred, the pupils were fixed, and painful stimuli did not produce a response. In addition respiration could not be sustained even for very short periods. Samples of the EEGs in which no alteration was noted with stimulation, are shown in figs 1 and 4.

Results

The computer file search revealed 35 patients who had alpha, beta or spindle coma during a ten year period. This represented 0.1% of all EEGs and 1.79% of patients who were comatose. There were 23 males and 12 females (table). Twenty-two patients had an alpha and nine a beta frequency pattern. In two these were combined. Two patients had tracings dominated by sleep spindle components. Males (16) showed the alpha pattern more often than females (7), but there were five males and four females with beta dominant records.

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Fig 1 The patient was fully unresponsive during a bedside recording, as for the other tracings illustrated. This sample taken the day following cardiorespiratory arrest shows a somewhat irregular moderate voltage 9 Hz non-responsive alpha activity, with a slight right sided amplitude enhancement. Anterior channels demonstrate semi-rhythmic slow activity of varying frequency and of slightly higher amplitude and greater amount on the right side. Calibration: vertical line 50µV, horizontal line 1 s, as in other figures.

When diagnosis was considered, 18 patients had had a cardiac arrest as a cause of coma with a variety of underlying disorders; five had a diagnosis of cerebrovascular accident and a similar number had had a head injury. There were four with a subarachnoid haemorrhage, two related to drug overdose and one following status epilepticus. Four patients recovered, two with drug overdose without arrest but with hypotension; one had a cardio-respiratory arrest soon after cardiac surgery and one following a severe road traffic accident resulting in multiple injuries including skull fracture. He survived with severe brain damage. This patient, like the survivor, following cardiac surgery

developed an alpha coma pattern EEG subsequent to a tracing dominated by delta components.

Serial recordings were available on 25 patients, 96 records in all, hence patterns of evolution of EEG change could be documented. These proved to be extremely variable, but three types were most commonly seen. Firstly the alpha pattern remained throughout the series, sometimes with diminution in amount, amplitude and frequency of the recorded activity. There were eight such patients. Secondly, in another five the alpha frequency activity remained until the final record or records of the series, which were isoelectric. Thirdly, in seven patients the alpha coma pattern developed during a series of recordings. The earlier tracings could be dominated by delta,

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Fig 2 One day after fig 1, the EEG is characterised by high voltage beta activity in the frontal channels. There is a tendency for spindling and a slight right sided preponderance.

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Fig 3 One day after fig 2, the tracing shows symmetrically disposed regularly recurring, high voltage delta waves coupled with sleep spindles, in the frontal leads.

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Fig 4 Three days after fig 3, the EEG is isoelectric. Note channel 5 records the EKG.

Table Age (yr) and sex of 35 patients with unusual coma patterns

	Range	Average age
Males (n = 23)	7-71	48
Females (n = 12)	14-73	43

theta or more or less continuous seizure discharge. Finally the remaining five showed other patterns, two with beta activity predominating and remaining unchanged throughout the series of recordings, one with spindle coma, likewise. A further patient initially showed an isoelectric tracing and then developed spindle activity. None had the sequence seen in the asthmatic patient. Little correspondence was found between aetiology and the evolution observed but a complex series of EEG changes generally followed cardio-respiratory arrest.

Discussion

As a result of the unusual sequence of EEG patterns found in the case reported, a search of the EEG department file was made.² The file now contains over 40 000 records on which patient identification, diagnostic and EEG information are available. This information is coded at the time the clinical report is made, using a specially devised series of definitions. In relation to alpha, beta and spindle coma these items are only indicated on the coding sheet when no response of the EEG pattern to stimulation has been a constant feature during the recording. A variety of stimuli in various modalities are used, care being taken that sufficient time, usually at least 20 seconds elapses between each presentation. Details of unusual coma patterns, thus coded, were obtained from the file and these formed the basis of the present commu-

nication. It was found that the alpha coma pattern is seen in all age groups but increasing numbers occur with increasing age, and these formed the basis of the present communication. It was found that the alpha coma pattern is seen in all age groups but increasing numbers occur with increasing age, though the phenomenon is rare before the age of 10 years. A male/female difference of 2 to 1 was noted. This latter feature was noted in a detailed recent report.¹

In common with many authors we found the prognosis of alpha coma and other unusual patterns is poor, especially after brain haemorrhage.³ Only four patients, three with alpha and one with spindle coma, in the 35 reported, survived. Of the survivors two had taken suicidal drug overdose, both recovered without brain damage. The other two developed an alpha coma pattern in a series of tracings, after the first EEG which nevertheless was grossly abnormal. Attention has already been drawn to this sequence,² and usually subsequent development of alpha frequency activity, the so called transitional alpha,⁴ carries a bad prognosis. In contrast in the present group there have been two survivors in this category, one following cardio-respiratory arrest after heart surgery and the other as a result of multiple injuries following a road traffic accident.

The asthmatic patient reported showed an unusual evolution of EEG findings that we have not previously observed or found in the literature. Alterations in level of arousal or rapid changes in electrolyte or metabolic state could possibly account for the features noted here but none such was observed. Unfortunately necropsy was refused so no information from the pathological standpoint is available. In a wider context, however, it is clear that a discrepancy between the frequency of activity and the conscious state must be viewed with extreme caution. The unresponsive nature of the elements recorded in contrast to the pathological delta episodes resulting from stimuli in certain obtunded patients⁵ is one particular factor which indicates an extremely poor prognosis. Only in patients following drug overdose may a good outcome occur regularly.

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