P_{CO_2} and C.S.F. pH in a direction predicted for such a neurogenic drive—namely, a relatively alkaline C.S.F. pH associated with a reduced P_{CO_2}.

The patients with C.S.F. haemorrhage showed a more acid C.S.F. at any given P_{CO_2} when compared with the non-haemorrhagic (Fig. 3). This increased acidity is presumably due to the presence of additional lactate and pyruvate consequent on the presence of blood in the subarachnoid space, but this does not apparently lead to any greater hyperventilation than might be caused by the postulated neurogenic drive. The data of Posner *et al.* (1968) also support the suggestion that a neurogenic drive is important in patients with haemorrhage into the C.S.F. in that the patients exhibiting hyperventilation had a normal rather than an acid C.S.F. pH despite the presence of higher C.S.F. lactate concentrations.

Conclusion

It is suggested that in most instances of hyperventilation in acute cerebrovascular disease a neurogenic drive is responsible. The presence of blood in the subarachnoid space and the associated rise in C.S.F. lactate may contribute towards the total ventilatory drive when the C.S.F. pH becomes more acid than normal, but even under these circumstances much of the ventilatory drive still appears to originate from a neurogenic source.

We are grateful to the physicians of the Nuffield Department of Medicine for allowing us to study patients under their care. One of us (D.J.L.) wishes to thank the Nuffield Committee for the Advancement of Medicine for financial support. Professor A. Crampton-Smith was a constant source of encouragement and advice.

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Epilepsy and Driving

R. D. H. MAXWELL, G. E. LEYSHON

British Medical Journal, 1971, 3, 12–15

Summary

The status of the epileptic applicant for a licence to drive a private motor vehicle has changed from total prohibition through a stage of partial approval subject to medical assessment to the present conditional right to a driving licence. We report a study of a series of patients which shows that many and probably most epileptics have obtained driving licences by concealment of their condition, yet the new regulations continue to expect true declarations. It is suggested that, in common with applicants for a public service vehicle or a heavy goods vehicle driving licence, the applicant for a licence to drive a private motor vehicle should provide a medical report of fitness. The epileptic should be included in a general category of medically restricted drivers subject to individual medical assessment.

Pinderfields General Hospital, Wakefield
R. D. H. MAXWELL, M.D., M.R.C.P.GLASG., Consultant-in-Charge, Department of Electrophysiology
West Riding County Council Health Department, Wakefield
G. E. LEYSHON, D.P.H., D.R.C.O.G., Principal Medical Officer

Introduction

Symonds (1948) advocated that epileptics who had been free from attacks for a specified period should be able to state a case for being granted a licence to drive. He based his opinion on the fact that much more had become known about epilepsy, especially from electroencephalography and from new and effective drug therapy. Suppression of seizures had become possible, and the policy of an absolute bar to driving was difficult to sustain because cases differed in aetiology and prognosis.

The acceptance of a more liberal viewpoint was slow, however, Schnitker (1963) recorded that in some parts of the United States an epileptic could get a licence to drive provided a physician stated that he would never have an epileptiform seizure. In Great Britain the view of Hierons (1956), that the liability to seizures was very small in a patient who had been free from them for three years while on medication and for another two years after discontinuing medication, met with a wide measure of medical approval. In 1964 a London stipendiary magistrate ruled that because a driver was being treated with anticonvulsant drugs it did not mean he was suffering from epilepsy. It was the difficulty of defining both legally and medically the meaning of "suffering" which prompted the Ministry of Transport to state in a memorandum in 1961: "In any case of doubt as to whether an applicant for a driving licence, or the holder of a driving licence, is debarred from holding a licence by reason that he is suffering from epilepsy, the licensing authority will, no doubt, consult the local county or county

borough medical officer of health with a view to obtaining any specialized medical advice necessary in the circumstances." Thus provision was made for specialist opinion on whether an applicant for a licence was still suffering from epilepsy and on his liability to future seizures, and if the licensing authority refused to grant a licence, the applicant could appeal to a magistrates' court.

Licensing authorities varied in their interpretation of the regulations. Some adhered strictly to the ruling that an epileptic should never drive, and others were more liberal and applied Hierons's recommendations. Since 1962 the procedure of the West Riding licensing authority has been to refer applicants who state they suffer from epilepsy to the county medical officer for investigation. Applicants sign a consent form permitting inquiry about their health to be made of the family doctor or a hospital consultant and also agreeing to a medical examination by the county medical officer or an independent specialist nominated by him. Most of the specialist opinions have been obtained from the department of electrophysiology at Pinderfields General Hospital, and the object in each case has been to find out whether epilepsy exists and the liability to further seizures.

The Motor Vehicles (Driving Licences) Regulations of 1970 state that an applicant for a licence who suffers from epilepsy "shall satisfy the conditions that (*a*) he shall have been free from any epileptic attack while awake for at least three years from the date when the licence is to have effect, (*b*) in the case of an applicant who has had such attacks while asleep during that period he shall have been subject to such attacks since before the beginning of that period, (*c*) the driving of a vehicle by him in pursuance of a licence is not likely to be a source of danger to the general public." Thus the epileptic has now a conditional right to drive. Of these conditions, however, (*a*) continues to place the responsibility for disclosure of epilepsy on the applicant, (*b*) gives special exemption to nocturnal epilepsy, and (*c*) is probably unlikely to be evoked without proof.

Many opinions have been published in Great Britain on epilepsy and driving. Elliott (1963) stated clearly the viewpoint of the county medical officer. Symonds (1948) discussed two cases and Webb (1955) recorded five cases. Kerr (1953) found that 7 out of 200 applicants to be bus drivers were epileptic. Pond and Bidwell (1960) noted that 19 out of 150 epileptics examined held driving licences, and Phemister (1961) recorded that 27 out of 60 male epileptics in his survey had licences. The factual information recorded is so limited that it seems probable that the Regulations have been based of necessity on opinions and have given more weight to representation by a minority rather than to the ill-defined welfare of the public in general. This article examines our experience, with special regard to the effect of the new Regulations.

Subjects

Three groups have been examined. (1) A total of 110 persons referred to the county medical officer by the licensing authority because of a possible diagnosis of epilepsy. These cases formed one-third of all cases (322) referred to the county medical officer for advice, because of a stated or suspected medical disability, during the period of 1962-70. (2) A total of 855 persons aged 18 to 65 years of age who attended the department of electrophysiology as outpatients during 1966-70. This group consisted of all the patients with medical, neurological, or psychiatric complaints investigated by electroencephalography, either as a routine or as part of diagnostic procedures, who were resident in the West Riding licensing area. It does not include inpatients or any persons referred by the county medical officer. (3) One hundred and two epileptics referred to the county medical officer from the licensing authority in the first four months after the new Regulations came into force in June 1970.

A coded system was adopted which preserved the anonymity of patients in the second group when their medical records were matched against the licensing records. The licensing department was unable to ascertain which drivers were epileptic and the electrophysiology department which patients were drivers.

Results

CASES REFERRED TO COUNTY MEDICAL OFFICER

In the series of 110 applicants (82 men, 28 women) referred to the county medical officer from the licensing authority, 90 (81%) merited further referral to the department of electrophysiology for specialist advice. A decision was made in the remainder on the history provided by the general practitioner. The mode of referral to the licensing authority was: self disclosure 81%; police and courts (usually after accidents) 15·4%; other (own doctor, relatives, etc.) 3·4%. The 90 applicants referred for specialist assessment were asked their reasons for wanting a licence and answered as follows: pleasure only 81%, essential for work 7%, cheaper travel than public transport 13%, convenience 10%, and as proof that their condition was cured 13%. Licences were granted to 31 of the 110 applicants.

PATIENTS EXAMINED AT DEPARTMENT OF ELECTROPHYSIOLOGY

In this series of 855 patients it was found from the records of the licensing authority that licences had been issued to 204 out of 534 males (38%) and to 48 out of 321 females (15%). These 855 patients were subdivided as follows to show the history with which they presented and the electroencephalographic findings (see Table):

Distribution of Licence Holders

History	E.E.G.	No. of Cases	No. with Licences
	Male Patients		
Definite	Definite	74	34 (45·9%)
	Possible	30	11 (36·7%)
	Negative	144	56 (38·9%)
Possible	Definite	23	11 (47·8%)
	Possible	39	21 (53·8%)
	Negative	45	24 (53·3%)
Negative	Definite	11	5 (45·5%)
	Possible	18	6 (33·3%)
	Negative	150	36 (24·0%)
Total		534	204 (38·0%)
	Female Patients		
Definite	Definite	56	8 (14·3%)
	Possible	25	3 (12·0%)
	Negative	55	13 (23·6%)
Possible	Definite	26	5 (19·2%)
	Possible	41	7 (17·1%)
	Negative	40	7 (17·5%)
Negative	Definite	7	
	Possible	24	
	Negative	47	5 (10·6%)
Total		321	48 (14·9%)
Grand total		855	252 (29·5%)

History.—Definite: a clear history of one or more epileptic seizures (248 men, 136 women). Possible: one or more disturbances of consciousness suggestive of the presence of epilepsy (107 men, 107 women). Negative: no history of disturbances of consciousness (179 men, 78 women).

Electroencephalography.—Definite: gross or marked changes of epileptic type (108 men, 89 women). Possible: minimal abnormalities of epileptic type (87 men, 90 women). Negative: recordings within normal limits, or showing no definite epileptic disturbance (339 men, 142 women).

Seizures had occurred on more than one occasion in 231 (93%) of the 248 men with a definite history of epilepsy and 151 (69%) were receiving anticonvulsant drugs. Six (2·4%) suffered nocturnal seizures only. The proportion of the 855 patients licensed to drive (29·5%) was lower than in the general

population of the West Riding (44%), but of the 248 men with a definite epileptic history, and thus precluded by the Regulations from driving, 101 (42·3%) held driving licences.

Traffic Violations.—No females in the series had been found guilty of violations of the Road Traffic Act. Fifty-nine male drivers had convictions—45 had been found guilty of driving in a manner likely to endanger other road users and 14 had been charged with licensing, insurance, or defective vehicle offences. Examination of the 101 male epileptics who held driving licences showed the following relationship of convictions to E.E.G. findings: of 34 with definite E.E.G. abnormality 13 (38·2%) were convicted; of 11 with possible E.E.G. abnormality 3 (27·3%) were convicted; and of 56 with normal E.E.G. 11 (19·6%) were convicted. These results may indicate a trend, but they are not statistically significant.

CASES REFERRED AFTER IMPLEMENTATION OF NEW REGULATIONS

Of the 102 cases referred to the county medical officer, 13 were still under consideration at the time of writing, but of the 89 cases in which a decision was reached, 79 (88%) were approved for a licence and 10 were refused. The refusals were made on the statement of the applicant or family doctor that the last attack had occurred within the preceding three years. In only eight cases was a specialist opinion sought. In one it was to confirm the diagnosis; in another because of a difference between the statement of the family doctor and the applicant; no report had been received from the family doctor in a third case; and in a fourth the family doctor stated that, though there had been no fits for over three years, the applicant was on such heavy sedation he might be danger to the public. A suspicion existed that two applicants who claimed nocturnal epilepsy had fits also during the day. Two cases of traumatic epilepsy suffered also from other neurological abnormalities. Fourteen applicants disclosed that they suffered from epilepsy in applying for renewal of existing licences, but stated that they had been free from attacks for more than three years.

NOCTURNAL EPILEPSY

The incidence of nocturnal epilepsy in the three groups was as follows: 6 (2·4%) out of 248 male epileptic patients examined in hospital, 7 (8%) out of 110 driving licence applicants referred to the county medical officer and 18 (18%) out of 102 applicants under the Regulations of 1970 from June to November 1970.

Discussion

Phemister (1961) determined that almost half of the epileptic men he examined had driving licences. The proportion is similar in our investigation. Phemister listed the reasons given for concealment of epilepsy by applicants, which reflected resentment of the social injustice of a prohibition from driving. Our inquiry showed that in only 7% was there a genuine need for a driving licence to maintain or further employment and that 13% sought licences as a proof of mastery over their condition.

The Research Committee of the College of General Practitioners (1960) provided an estimate of 0·63 new case of epilepsy annually per thousand of the population, 40% of whom were of driving age. The West Riding licensing authority area has a population of 1,750,000, so that the annual number of epileptics who could apply for a driving licence should be 440 of whom 220 would be males. The number who disclosed epilepsy over the eight-year period examined was nine per year, about 4%. Since 42·3% of the male epileptics in group 2 of our series have licences it seems that some 9 out of 10 male epileptic drivers may have concealed their illness in violation of the Road Traffic Act of 1961. Though a licensing authority has a responsibility to satisfy itself of the veracity of applicants' statements, this must depend almost entirely on self-disclosure, as occurred in 81% in our series.

The difficulties in proving concealment of diagnosis are formidable, and we know of only one prosecution, based on a confession. The possibility of an epileptic being held legally responsible for damages after a seizure while driving is remote. The *British Medical Journal* (1970) indicated that a plea of automatism is likely to be successful, except by a notoriously epileptic person, so that the penalty after accidents due to epileptic siezures is limited probably to suspension of the licence for three years under the existing Regulations.

The Department of Environment's statistics show that there were 363,350 road victims, including 7,500 killed, in 1970, and even with the estimate in Social Studies in Epilepsy (1966) that only 0·3 to 1 per 1,000 road accidents are attributable to epilepsy, prohibitive measures may have some justification. The value of electroencephalographic examination in relation to fitness to drive is suggested by the report by Lennox-Buchthal *et al.* (1960), who found that in military jet aeroplane pilots, on whom the effect of an epileptic seizure is likely to be unequivocal, the crash rate of those with pronounced paroxysmal E.E.G. abnormalities was no less than three times higher than in those with normal or slightly abnormal records. In Holland, Lorentz de Haas (1965) noted that electroencephalography must be included in the assessment of the fitness of an epileptic to drive.

Conclusion

It is difficult to reconcile charge of a mechanism of lethal potentialities with any state of impaired or involuntary loss of consciousness. The apparently more permissive Regulations of 1970 are likely to sustain the previously existing tendency to obtain a licence undeterred by the penalties for making a false declaration. The Regulations have transferred the subject of prevarication from diagnosis to the timing and frequency of seizures—the very matters which occasion concern in assessing fitness to drive. If the intention of the Regulations is to promote self-disclosure our figures, showing a substantial increase in the number of successful applications in the first three months after the regulations came into force, indicate that the objective has been achieved. However, this may be limited to those applicants who are able to conform to the requirement of three years' freedom from seizures or of only nocturnal attacks. The effect on road safety of the new law granting epileptics a conditional right to drive is unlikely to be demonstrable, since most epileptics have not conformed to the previous legislation.

In many countries the epileptic has been included in the general category of medically restricted drivers, subject to individual assessment and periodic review. The validity of this is exemplified in Medical Aspects of Fitness to Drive Vehicles (1968) in which epilepsy is reviewed properly in the context of those other conditions which may equally impair control of a vehicle. The problem remains of detecting the epileptic applicant. An extension of the Motor Vehicle Licensing Act of 1969 which provides for a computer-based central licensing system to include health records would be opposed strongly, so would compulsory notification of epilepsy as exists in the epilepsy-reporting laws in California. However, the Road Traffic Act of 1960 and the Road Safety Act of 1967 require applicants who drive public service and heavy goods vehicles to provide a medical report from their general practitioners on their fitness to drive. An extension of this requirement to include applicants for a licence to drive a private vehicle would provide factual information. The category of medically restricted drivers identified would include epileptics, who would then be subject to individual assessment without prejudice or special legislative differentiation.

We are indebted to Dr. R. W. Elliott, County Medical Officer of Health, for his advice and encouragement and to Dr. H. W. S. Francis, Deputy County Medical Officer of Health, for administrative help in arranging this investigation. We are grateful to Mr. J. V. Williams and the staff of the West Riding Licensing Department for their co-operation, and the Ministry of Transport for allowing us access to their records. Our thanks are due also to Miss P. S. Crook, chief technician, Mrs. L. J. Dudlyke, secretary, and the staff of the department of electrophysiology.

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Association of Oedema and Hypomagnesaemia with Hypocalcaemic Tetany of the Newborn

MALCOLM L. CHISWICK

British Medical Journal, 1971, **3**, 15–18

Summary

The cases of 18 babies with hypocalcaemic tetany of the newborn are described. Studies were made before and 24 and 48 hours after therapy with calcium supplements. Twelve of the babies were non-oedematous and showed a positive correlation between serum calcium and magnesium levels. They showed a rise in serum magnesium levels during therapy with calcium. The other six had bilateral pitting oedema of the feet and greater weight gains in the first two weeks of life. They had abnormally low serum magnesium levels which did not correlate with the calcium levels. Furthermore, the serum magnesium levels, unlike those in the non-oedematous group, did not increase when calcium supplements were given. It is suggested that oedema in babies with hypocalcaemic tetany may be more common than is generally recognized, and that a contributory factor in the production of the hypomagnesaemia may be secondary aldosteronism.

Introduction

Hypocalcaemic tetany of the newborn may occur in a variety of clinical situations, and several factors are involved in the pathogenesis (Anast, 1969). Clinically, the manifestations of hypomagnesaemia are indistinguishable from hypocalcaemia, and the two conditions may coexist in hypocalcaemic tetany of the newborn. Primary hypomagnesaemia with secondary hypocalcaemia has been described, the evidence suggesting isolated malabsorption of magnesium from the gastrointestinal tract (Friedman *et al.*, 1967). Whether tetany ever occurs in magnesium-deficient babies with normal serum calcium levels is a controversial point (Gellis, 1970). The incidence of hypomagnesaemia in association with hypocalcaemic tetany of the newborn is difficult to assess. Most babies with hypocalcaemic tetany respond to calcium therapy without the need to resort to magnesium supplements, and not all laboratories perform the estimation routinely. Various methods are used for the determination of serum magnesium levels, and these do not all give comparable results. Keen (1969) made serum magnesium estimations on 13 babies with hypocalcaemic tetany, and four of them had levels below 1·2 mEq/l. This was low by his standards, but it is not known if magnesium supplements were required to control the tetany. It is not known what factors govern the production of the abnormally low serum magnesium levels sometimes seen in this condition. This paper describes an association between oedema and hypomagnesaemia in newborn babies with hypocalcaemic tetany.

Special Care Nursery, Southampton General Hospital, Southampton, Hants
MALCOLM L. CHISWICK, M.R.C.P., D.C.H., Registrar in Paediatrics (At present Registrar in Paediatrics, St. George's Hospital, London S.W.17)

Method

Babies who presented with twitching in the first two weeks of life associated with a serum calcium level of 7 mg/100 ml or below were studied. A history, with particular attention to the pregnancy, mode of delivery, condition immediately after birth, and behaviour before the development of symptoms, was obtained in retrospect. During the initial examination, in addition to a careful neurological evaluation, attention was given to the presence of pitting oedema of the feet. This physical sign was elicited by moderate pressure of the examiner's thumb on the dorsum of the babies' feet for not longer than five seconds.

After an initial feed of 5% dextrose all the babies were fed on full cream National dried milk in full strength, in amounts varying from 90-160 ml/kg/24 hours on the second day to 140-160 ml/kg/24 hours on the sixth day and throughout therapy. The milk feeds began 10 to 18 hours after birth in all cases. Most of the babies were weighed at intervals of 48 hours, but some, including all those who were oedematous, were weighed at intervals of 24 hours.

Venous blood was taken at the onset of twitching and at 24 and 48 hours after the beginning of therapy. A further specimen of venous blood was taken from the babies with oedema after it had subsided. The chemical analyses were performed by automated procedures, serum calcium by flame photometry (Auto-Analyzer N21a), serum magnesium by atomic absorption spectroscopy, serum total protein by Technicon method file N14b, serum total globulins by turbimetry (Glenn, 1965), and serum albumin was calculated by difference from the last two methods. A Dextrostix determination was performed on all babies initially, capillary blood being used. A blood urea