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Recommended Citation

Walter P. Mahle, Medico-Legal Aspects of the Electroencephalogram, 11 Clev.-Marshall L. Rev. 544 (1962)

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Medico-Legal Aspects of the Electroencephalogram

*Walter P. Mahle**

HHEAD TRAUMA is responsible for more litigation than any other single bodily mechanical damage.¹ Pleading and proving brain injury presents one of the greatest challenges to the personal injury lawyer. In many other types of injuries, where there is visible evidence of the trauma, such as scars, improperly healed fractures, loss of sight or hearing, artificial limbs, etc., there is no problem. The jury can readily see the result of the injury and come to a reasonable evaluation which is reflected in the judgment.

Injury to the brain may result in malfunctioning of various other organs of the body which are apparent. Many of the effects of brain injury, however do not show up for months or occasionally years after the injury. The average jurist has little or no medical background. The more complex and obscure the injury the more difficult becomes the lawyer's task. The effect of trauma to the brain may not be so apparent as to be understood by the jurist. Even where it is understandable, future effects and disability cannot be accurately evaluated by medical experts, much less the jurist.

Demonstrative Evidence

In head injury cases, the jury must understand complicated portions of the human anatomy and the lawyer should, therefore, use any demonstrative method that will make it easy for the jurors to understand the medical issues. This may be done by the use of medical drawings, scale models, line drawings on x-ray films—all of which show the anatomy of the brain and the skull. These are essential for the jury in order to understand the complex testimony of medical experts who are describing the head injuries and nervous conditions observed by them. A relative newcomer to the field of demonstrative evidence is the electroencephalogram, commonly referred to as the "E. E. G." It is

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¹ Schroeder, *The Head: A Law Medicine Problem*. Institute of the Law Medicine Center, Western Res. Univ., p. 28 (1957).

something that can be seen by the jury. The difference between a normal tracing and the abnormal tracing is very apparent and dramatic when explained to the jury by the medical expert.

The Electroencephalogram

Electroencephalograms are beginning to assume more importance in the proof of head injuries. They have been used more extensively in the past fifteen to twenty years. It is believed in the future they will gain greater acceptance and be used as widely as the electrocardiogram. One of the most complete texts on the subject of electroencephalography is the *Atlas of Encephalography*.² The electroencephalogram was introduced by a German, Hans Berger, in 1929. He found that small electrical impulses traced consistent pathways over the nervous tissues of the human body and also over the brain. The electrical impulses are picked up by electrodes placed on the scalp and are amplified a million or more times, and then by means of ink-writing ascillographic pens, it is possible to make a record on paper.

Four types of rhythms have been described in the "normal" human encephalogram.³ The most common, or "alpha rhythm" consists of a regular series of smooth waves occurring at a frequency of between eight and twelve cycles per second and is most common in the parieto-occipital cortex (posterior of the head). The second or "beta rhythm," is most prominent in the frontal cortex and has a frequency of thirteen to thirty-two cycles per second. The third, and possibly least common, or "gamma rhythm" arises from the frontal lobes and has frequencies of thirty-three to fifty-five cycles per second. The fourth or "delta rhythm" is similar to alpha but is slower one to eight cycles per second.

In the average child, the alpha rhythm predominates. As the child develops, there is an increase of the beta rhythms. The "normal adult" patterns do not develop until eight to twelve years of age.

It is believed that all experts agree that the electroencephalogram only records the waves from the cerebral cortex but does not record activity from the deep cerebrum, cerebellum, or medulla.

² Gibbs and Gibbs, *Atlas of Encyphalography* (1941).

³ Nelson, *Textbook of Pediatrics* 1338 (5th ed. 1945).

Berger found that the frequency and amplitude of these electrical impulses given off by the brain, change in a predictable manner with the age of the patient in waking and sleeping, and with certain diseases, particularly of the nervous system. When there is a malfunctioning or irritation of the nervous system, there are changes in the electrical activity of that area which are reflected on the graph.

Dr. Fredric A. Gibbs states:⁴

The specific medical conditions in which electroencephalogram is most useful are the following: epilepsy, cerebral tumor, subdural hematoma, cerebral hemorrhage, cerebral thrombosis, cerebral abscesses, meningitis, encephalitis, Schilders disease, and behavior disorders of an epileptic or postencephalitic type.

He points out, as do all authorities in the field, that the E. E. G., though a valuable diagnostic tool, should be considered in conjunction with all other evidence and clinical findings available.

Epilepsy

Of the preceding diseases listed by Gibbs where the E. E. G. is a valuable diagnostic aid, those which are most important to the lawyer are epilepsy, subdural hematoma, cerebral hemorrhage, and encephalitis; as these diseases most commonly may be caused by trauma. The subdural hematoma, cerebral hemorrhage, and encephalitis can usually be supported by other clinical tests, or at least are resolved long before the case reaches litigation. The most common use of the E. E. G. in trial work is to support epilepsy, or that there has been trauma to the brain which may later result in epilepsy. It was formerly believed that epilepsy was a disease in itself but now it is considered a symptom of many diseases. It is regarded as a disturbance in the electro-physio chemical activity of the discharging cells of the brain. Such disturbance may become manifest where an irritative stimuli impinge on the brain cell. The form of the disturbance may become evident as: (a) disturbance of consciousness; (b) disordered functioning of the autonomic nervous system; (c) convulsive movements; or (d) change in the electric potential (as recorded in the electroencephalogram).⁵

⁴ Gibbs, *Medicolegal Aspects of Encephalography*, 5 *Canad. Rev.* 361 (1946).

⁵ 4 *Am. Jur. Proof of Facts* 700.

The attorney trying a brain injury case in which he is alleging epileptic symptoms of his client, should determine: (1) if there were any epileptic symptoms prior to the trauma; (2) if there were any E. E. G. performed prior to the accident; (3) if there is any family history of epilepsy; (4) if his client had any prior injuries or diseases which may cause epilepsy; (5) he should have an E. E. G. performed as soon as possible following trauma. (Gibbs⁶ goes so far as to suggest that an E. E. G. should be obtained in all accident cases, "because of the close relationship of head injury, electroencephalographic abnormality and epilepsy.")

Some normal persons have abnormal brain waves. This has been estimated by various authors at ten to fifteen percent. There is also a small percentage of people with epileptic symptoms which have no abnormal tracings. It is therefore wise from a clinical standpoint, as well as from the standpoint of offering better evidence at trial, to have serial electroencephalograms performed. The first as soon as possible after trauma; the second six months to one year after trauma; and a third, possibly, a year later. If the later tracings show a more normal pattern than the original one, it would tend to show a causal relationship between the trauma and the abnormality in the original tracing. If the later tracings become progressively more abnormal, it would also show a causal relationship between the trauma and the abnormal tracing. Where the abnormality is mild following trauma and continues through the series with the same mild abnormalities, there is a presumption they were in existence at the time of the trauma. If you are fortunate enough to have E. E. G.'s of the client showing his normal pattern prior to the trauma and then have an abnormal tracing following trauma, it is easier to meet the burden of proof. When the abnormality is focal (pertains to only one portion of the head while all others are normal) and conforms perfectly to the area of the trauma or injury, the evidence that the accident caused the injury is almost impossible to overcome.

Limitations

It is important that both plaintiff and defendant's lawyer understand the limitations of the E. E. G. both as a diagnostic tool and as evidence. The electroencephalogram is not a record of all brain activity but merely a record of a special type of

⁶ Gibbs, *op. cit. supra*, n. 4.

activity from the outer surface of the brain. Gibbs⁷ reports that "the E. E. G. may appear perfectly normal even though a large cortical area has failed to develop, has completely atrophied or has been surgically removed."

Since the electrical impulses given off by the brain are so minute, they must be magnified greatly so that it is possible to record them. The E. E. G. machine which does this is very sensitive and radiation from the machine itself or electrical disturbance nearby may be recorded on the paper thus distorting the pattern. Restless body movements by the patient will produce artifacts which are recorded on the tracing. These may be identified by the expert encephalographer as artifacts but may be interpreted by the inexperienced as abnormal tracings. Other things which will affect the test and result in an untrue picture is if the patient has been smoking, taking drugs or fasting within the preceding twelve-hour period. If the electrodes are not securely attached to the skull it may result in a defect in the tracing. Rapid breathing by the patient may vary the E. E. G. pattern. If the patient is nervous or apprehensive about taking the test, this may be reflected in the tracing. Most of the above possibilities can be guarded against by the doctor or technician performing the test.

It is apparent that the adequacy of the machine used to give the test is of vital importance in reflecting accurately the activity from the surface of the brain. Assuming that the lines on the paper are accurate, the task of diagnosis is only begun. The tracing must then be interpreted by experts in the field and the accuracy of their interpretation is open to question.⁸

In one study of this problem, the tracings of ten patients were examined by five experts in the field. Eight of the patients were subsequently shown to be suffering from disorders of the central nervous system. The percentage of agreement among the experts was forty percent on pathology, thirty percent on localization, and only ten percent on both combined.

Even though there are limitations to the E. E. G., the technique is a valuable diagnostic aid. It should be remembered that it should be utilized only in conjunction with all other clinical and investigative methods available.

⁷ Gibbs, *op. cit. supra*, n. 4 at 363.

⁸ *Supra*, n. 5 at Supp. 33.

Admissibility

There does not appear to be any problem in having electroencephalogram admitted as evidence in most jurisdictions as long as certain qualifications are complied with. The E. E. G., though relatively new in the field of medical evidence, has made its entrance into the field with much less difficulty than the x-ray and the electrocardiogram (E. K. G.) which preceded it. In most jurisdictions, the qualifications applicable to the x-ray and the E. K. G. are also applicable to the E. E. G. The above listed medical tests are all electronic devices. They all furnish objectives rather than subjective evidence of the injury. They have the same general limitations in that their validity depends greatly on the technician who administers them and the expert who interprets the result of the tests. Much relies on the dependability of the machine used to perform the test.

One of the first cases dealing with the admissibility of the x-ray was *March vs. The City of Hartford*⁹ wherein the Court said:

It is the duty of the Courts to use every means for discovering the truth, reasonably calculated to aid in that regard. In the performance of that duty, every new discovery, when it shall have passed beyond the experimental stage, must necessarily be treated as a new aid in the administration of justice in the field discovered for it. In that view, Courts have shown no hesitancy in proper cases, of availing themselves of the art of photography by the x-ray process.

The admissibility of graphs or other records of medical tests of this type is a matter primarily for the discretion of the trial court, subject to renewal for abuse.¹⁰

The rule that documentary evidence which violates the hearsay rule is inadmissible, has been applied to the results of such tests.¹¹ The qualifications which must be met before electroencephalographs are admissible vary from one jurisdiction to another, but in any event fit under two major categories: (a) business records as evidence or (b) the same rules applicable for x-rays on photographs.

⁹ 112 Wis. 40, 87 N. W. 816, 819 (1901).

¹⁰ 66 A. L. R. 2d 541 (1959).

¹¹ *Depfer vs. Walker*, 125 Fla. 189, 169 So. 660 (1935).

Business Records Statute

Those states having a Business Records as Evidence Statute may look to the statute to determine the qualification which must be met. The Ohio Statute is in part as follows:¹²

A record of an act, condition, or events in so far as relevant, is competent evidence if the custodian or the person who made such record—or under whose supervision such record was made testified to its identity and the mode of its preparation and if it was made in the regular course of business—at or near the time of the act, condition or event, and if in the opinion of the court, the sources of information, method and time of preparation were such to justify its admission.

A leading Pennsylvania Case¹³ set out three rules which must be complied with to make such evidence admissible:

1. Such records must be made contemporaneously with the acts to which they purport to relate;
2. There must have been present, at the time, no contemplative motive for falsification; and,
3. They must have been made by a person having knowledge of the facts set forth, or one competent to predicate a medical and scientific opinion of the facts.

A later Pennsylvania court¹⁴ in commenting on the above case said:

If any doubt as to the last point existed, it is resolved by the Uniform Business Records as Evidence Act, which makes competent a cardiogram prepared by a physician.

A New York case¹⁵ held it was prejudicial error to exclude the E. E. G. and records respecting it made in the regular course of business.

In areas, where there is no Business Records as Evidence Act, the qualifications for admissibility are more difficult to determine. The court in *Melford vs. Gaus and Brown Construction Company*¹⁶ recognized that the principles applicable to x-rays would govern the admissibility of exhibits relating to electroencephalograms. There appears to be four major qualifi-

¹² Ohio Rev. Code, Sec. 2317.40.

¹³ Paxos vs. Jarka Corp., 314 Pa. 148, 171 A. 468 (1934).

¹⁴ Freedman vs. Mutual L. Ins. Co., 342 Pa. 404, 21 A. 2d 81 (1941).

¹⁵ Mayole vs. B. Crystal and Sons Inc., 266 App. Div. 1008, 44 N. Y. S. 2d 411 (1943).

¹⁶ 17 Ill. App. 2d 497, 151 N. E. 2d 128 (1958).

cations which must be met before such exhibits will be admissible. They are as follows:

- (A) *Proper Identification*—They should be marked at the time the test is performed indicating: the name and address of the patient; the date, time, and place where the test was performed. Some courts hold that they must be identified by the technician performing the test.¹⁷
- (B) *Accuracy of the Instrument used to make the test.* It should be able to record, without distortion, all frequencies between one and seventy per second. In this frequency range, it should not, as a result of defective tubes, batteries, wiring, or poor design, generate electrical disturbances that will be recorded and confused with electroencephalogram, i.e., the noise levels should be below two micro volts.¹⁸ E. E. G. records should be written on a paper moving at three cm. per second, which is the standard speed for the United States. The instrument should be properly calibrated.
- (C) *Validity of the results of the test.* There should be testimony offered; that the instrument was properly calibrated before the test was begun; that the electrodes were securely attached to the skull; that there were no electrical disturbances nor patient disturbances; that the patient had not been smoking or taking drugs immediately before the test was performed.
- (D) *Proof of the competency of the technician performing the tests.* This can be brought out by showing the education, training, and experience of the technician. It is usually better if the test is performed under the supervision of a doctor who is an expert in the field.

In the *Melford* case,¹⁹ there were five electroencephalograms made under Dr. Gibbs' supervision. These were dated 1950, 1955,

¹⁷ *Quadlander vs. Kansas City Publishing Co.*, 240 Mo. App. 134, 224 S. W. 396 (1941).

¹⁸ *Gibbs, op. cit. supra*, n. 4 at 364.

¹⁹ *Supra*, n. 16.

and 1956. The last two E. E. G. were used to sustain the injury findings of "spike seizures." These E. E. G. contained the name and address of Melford. It also contained the name of his doctor and the name and address of his attorney. One tracing was ten feet long dated October 19, 1950. There was also an E. E. G. sixty feet long and had an office record referring to Melford pasted on the reverse side. Dr. Gibbs, the expert, testified as to the adequacy of his E. E. G. equipment. He stated that when E. E. G. are made in his office, he sets up model conditions with disturbances to the patient being at a minimum.

The defendant contended that the court should follow the holding in *Quadlander vs. Kansas City Public Service Company*.²⁰ That court held the same "principles and requirements" governing x-rays should apply to cardiograms. The Melford Court said that they had previously "rejected the argument that x-rays should not be admitted for the sole reason that the technician who took the pictures was not produced as a witness. In the *Melford* case, the technician who performed the test was not called on as a witness. Dr. Gibbs did testify that the tests were performed under his supervision.

The Court in *Melford vs. Gaus and Brown Construction Company*²¹ in allowing the electroencephalogram said:

We think the medical evidence is not "speculative" and the jury could infer that there was reasonable medical certainty that the tholmic epilepsy would grow progressively worse. . . . We think there was sufficient showing made of the causal connection between the fall of Melford Jr. and his injury in the testimony of Melford Jr., of his mother, and his pediatrician, and of three expert witnesses whose testimony was not rebutted.

A Missouri case²² went further and permitted the introduction of an E. E. G., not of the plaintiff, into evidence. The plaintiff's exhibit was identified, by the doctor, merely as a normal E. E. G. of a patient, which was an adult, approximately the same age as the plaintiff, an eight channel recording showing perfectly normal activity. This exhibit was submitted for the purpose of permitting the doctor to make a comparison and illustrate his testimony with reference to his findings concerning the ab-

²⁰ *Supra*, n. 17 at 401.

²¹ *Supra*, n. 16.

²² *Berry vs. Harmon*, 329 S. W. 2d 784 (Mo. 1959).

normal condition of the plaintiff's brain, as shown by an electroencephalogram taken of the plaintiff by the witness.

Summary

Brain injuries are difficult to prove and the lawyer must use all demonstrative evidence available to him to make the jury aware of the injury to his client. The electroencephalogram, though it has only been used as a diagnostic tool and as demonstrative evidence for the last fifteen to twenty years, is becoming more important in this field. It is becoming a more exact science and, it is believed, will be used more widely in the future. There does not appear to be any great problem of admissibility where they are properly identified, performed by competent technicians, using adequate equipment, and which accurately represent the information they are intended to reveal. If they serve the cause of justice and are relevant and material to the medical issues to be determined, courts everywhere will admit them for that purpose.