ORIGINAL ARTICLE

EEG in Suspected Syncope: Do EEGs Ordered by Neurologists Give a Higher Yield?

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ABSTRACT: ***Background:*** Prior studies have shown that the electroencephalogram (EEG) is of low diagnostic yield in the evaluation of syncope but have not looked at the yield according to referring physician specialty. The goals of this study were to determine if the yield of the EEG is higher when ordered by neurologists and whether EEGs with abnormal findings resulted in any significant change in patient management. ***Methods:*** We retrospectively reviewed the records of the EEGs requested for a clinical diagnosis of syncope, convulsive syncope, loss of consciousness, or falls from 2003 to 2007 at our institution. We obtained further information from the medical record of patients with an abnormal EEG. ***Results:*** Of 517 EEGs meeting our inclusion criteria, only 57 (11.0%) were read as abnormal. No EEG was positive for epileptiform activity and only 9 (1.6%) showed potentially epileptic activity. EEGs ordered by neurologists did not have a higher yield compared to non-neurologists. Five abnormal EEGs resulted in further investigations being ordered. One patient was ultimately started on phenytoin. ***Conclusions:*** EEGs requested for the evaluation of patients with suspected syncope have an extremely low diagnostic yield and do not significantly alter the management of the patients, regardless of the specialty of the referring physician.

RÉSUMÉ: L'EEG chez les patients suspects de syncope : les EEG demandés par les neurologues donnent-ils un meilleur rendement? : ***Contexte :*** Des études antérieures ont montré que l'électroencéphalogramme (EEG) offre un rendement diagnostique faible dans l'évaluation de la syncope, mais ces études n'ont pas examiné le rendement selon la spécialité du médecin qui réfère le patient. Les buts de cette étude étaient de déterminer si le rendement de l'EEG est plus élevé quand il est demandé par un neurologue et si les EEG dont les résultats sont anormaux entraînaient des changements significatifs dans le traitement du patient. ***Méthodes :***Nous avons revu de façon rétrospective les dossiers des EEG demandés de 2003 à 2007 dans notre institution à cause d'un diagnostic clinique de syncope, de syncope convulsive, de perte de conscience ou de chute. Nous avons tiré des informations complémentaires des dossiers médicaux des patients dont l'EEG était anormal. ***Résultats :*** Seulement 57 (11,0%) des 517 EEG qui rencontraient nos critères d'inclusion ont été interprétés comme étant anormaux. Aucun EEG n'a montré d'activité épileptiforme et seulement 9 (1,6%) présentaient une activité épileptique potentielle. Les EEG demandés par les neurologues ne fournissaient pas un rendement supérieur à ceux demandés par des non-neurologues. Cinq EEG anormaux ont donné lieu à d'autres évaluations. Un patient a éventuellement reçu de la phénitoïne. ***Conclusions :*** Les EEG demandés en cours d'évaluation chez des patients suspects de syncope ont un rendement diagnostique extrêmement faible et ne changent pas significativement le traitement des patients, quelle que soit la spécialité du médecin qui réfère le patient.

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Syncope is often difficult to distinguish from a seizure because both can present clinically with a transient loss of consciousness[1]. Published studies have found that the electroencephalogram (EEG) is of low diagnostic yield when the clinical diagnosis is syncope[2-5]. Reviews state that EEGs should not be performed routinely in cases of suspected syncope unless there has been a witnessed seizure[6], there is a history of prior seizures[7,8], or there are "symptoms suggestive of a seizure"[7,9]. Electroencephalograms ordered by a neurologist might be expected to have a higher diagnostic yield because most neurologists are experienced in evaluating patients with syncope and seizures, and presumably would only refer a patient with suspected syncope for an EEG if there was something concerning in their history. However, no prior publications have looked at the yield of the EEG according to the specialty of the referring physician.

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The primary goals of this study were to determine the yield of EEGs in the evaluation of patients with suspected syncope over the past five years at our institution, to determine if the yield was higher for EEGs ordered by neurologists, and to determine if EEGs with abnormal findings resulted in any significant change in patient management.

Methods

The records of all EEGs performed at the Jewish General Hospital (Montreal, Quebec, Canada) from January 2003 to December 2007 were reviewed by the two investigators to identify the EEGs requested for a clinical diagnosis of syncope, convulsive syncope, unexplained loss of consciousness, or falls. Patients with unexplained loss of consciousness or falls were included to account for patients with suspected syncope who might have been labelled differently on the requisition form.

All patients had been seen by the referring physician before the EEG was requested. Electrodes were placed according to the 10-20 system of the International Federation. Prior to November 2004, EEGs were recorded on an 8-channel paper machine (Grass Instrument Co) with four different bipolar montages and one referential montage. After November 2004, EEGs were recorded on a 16-channel digital machine (Stellate Systems) with three bipolar and one referential montage. All recordings included an EKG channel. The standard length of the recording was at least 25 minutes. The EEGs were read and reported by two Royal College of Physicians and Surgeons of Canada-certified neurologists (of a total of 11 in the department).

The following information was extracted from the EEG reports and entered into an anonymous database: EEG identification number; patient age and sex; patient location (inpatient, outpatient, emergency room (ER)); the referring physician (neurologist, neurologist specialized in autonomic dysfunction, family physician, emergency physician, internist, other); EEG result (epileptic, potentially epileptic, generalized slowing, focal slowing, or normal); prior EEGs performed. An EEG was considered abnormal if it contained epileptic activity, potentially epileptic activity, generalized slowing or focal slowing. From this data, the overall yield of the EEG (percentage with any abnormalities) was calculated. We also calculated the yield according to referring physician specialty, patient location, and indication (syncope, convulsive syncope, unexplained loss of consciousness, or falls) and compared the results using a Chi-squared test.

In the second stage of this study, further information was obtained concerning the clinical history of the patients with EEG results other than normal. This was done by reviewing the hospital charts and clinic charts. We excluded EEGs performed on patients with a past history of seizures, or who had previously undergone EEGs for the investigation of syncope. It was specifically noted whether or not the EEG changed the management of the patient. If this information could not be determined from review of the clinic or hospital chart then a letter was sent to the referring physician of the patient. The percentage of patients for whom the EEG changed their management was compared according to referring physician specialty, patient location, and indication.

We estimated the potential cost savings at our institution by multiplying the cost of performing an EEG ($234.25, as defined by the Régie de l'assurance maladie du Québec) by the number of normal EEGs done for patients with suspected syncope per year on average.

The protocol was approved by the research ethics board of our institution (Jewish General Hospital, Montreal, Canada).

Results

A total of 3 494 EEGs were performed from January 2003 to December 2007 inclusively. Of these EEGs, 517 (14.8%) were requested for suspected syncope, convulsive syncope, unexplained loss of consciousness, or falls (Table 1). Overall, 210 of the subjects were men and 307 were women, the average age was 58-years-old, and the median time to obtain the EEG was 14 days (Table 1). Eighty-eight of the 517 EEGs (17%) were performed within 24 hrs of the event. Of these 517 requisitions, 62 EEGs were read as abnormal. Five of these EEGs were excluded from the study upon review of the medical chart; three because of a pre-existing seizure disorder, one because of dilantin toxicity, and one because the patient had been investigated for recurrent syncope with three previous EEGs. This left 57 (11.0%) abnormal EEGs; 7 (1.4 %) were potentially epileptic, 14 (2.7 %) had generalized slowing, and 37 (7.2 %) had focal slowing. No EEGs were read as containing epileptiform activity (Table 1).

The yield of the EEG according to referring physician, patient location, and indication is shown in Tables 2a to 2c. There was a statistically significant difference in the yield according to referring physician ($p<0.011$). Both emergency physicians and internists had a higher yield. There was also a statistically significant difference according to patient location ($p<0.0001$), with in-patients and ER patients having a higher yield than out-patients. Of the patients seen by internists, 81% were inpatients

Table 1: EEGs requested for the evaluation of patients with suspected syncope

"Syncope" EEGs*	517
Median time to obtain (days)	14
Average age (years)	58
Male (%)	40.7
RESULT	
Epileptic	0
Potentially epileptic	6
Generalized slowing	14
Focal Slowing	37
Normal	459

*EEGs requested for a diagnosis of loss of consciousness, falls, syncope, or convulsive syncope.

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Table 2a: Yield of the EEG according to referring physician

	Neurologist	Autonomic[2]	GP	ER	Internist	TOTAL
Abnormal EEGs[1] [Number (%)]	24/304 (7.9)	5/56 (8.9)	8/70 (11.4)	7/40 (17.5)	13/47 (27.7)	57/517 (11.0)
EEGs that changed management [Number (%)]	2/304 (0.7)	0/56 (0.0)	2/70 (2.9)	0/40 (0.0)	1/47 (2.1)	5/517 (1.0)

[1]Number of abnormal EEGs compared to the total number of EEGs ordered by physicians from each specialty; Chi-square 18.27, p<0.011;
[2]Autonomic: neurologist specialized in autonomic dysfunction. GP=general practitioner; ER=emergency room physician

Table 2b: Yield of the EEG according to patient location

	In-patient	Out-patient	ER	TOTAL
Abnormal EEGs* [Number (%)]	16/65 (24.6)	28/392 (7.1)	13/60 (21.7)	57/517 (11.0)
EEGs that changed management [Number (%)]	1/65 (1.5)	3/392 (0.8)	1/60 (1.7)	5/517 (1.0)

*Number of abnormal EEGs compared to the total number of EEGs ordered from each location; Chi square 25.19, p<0.0001. ER=emergency room physician

Table 2c: Yield of the EEG according to indication

	Loss of Consciousness	Fall	Syncope	Convulsive Syncope	TOTAL
Abnormal EEGs* [Number (%)]	24/239 (10.0)	5/28 (17.9)	24/230 (10.4)	4/20 (20.0)	57/517 (11.0)
EEGs that changed management [Number (%)]	3/239 (1.3)	1/28 (3.6)	1/230 (0.4)	0/20 (0.0)	5/517 (1.0)

* Number of abnormal EEGs compared to the total number of EEGs ordered for each indication; Chi square 3.29, p<0.349.

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or patients from the ER compared to 12.8% for neurologists. The median time to obtain the EEG was one day for emergency physicians, two days for internists, and 18.5 days for neurologists.

Of the abnormal EEGs, only five possibly resulted in a change in the management of the patients (Tables 2a-2c). In four cases, this was minimal and consisted only of ordering further investigations. In two of these cases a follow-up, sleep deprived EEG was ordered but showed no change. In the third case a follow-up, sleep-deprived EEG was ordered but the patient was lost to follow-up before it could be obtained. The fourth case resulted in a CT scan of the head and a neurology consult being requested, the results of which are unknown.

Ultimately, in only one case was there a definite change in management of the patient. A 94-year-old woman with dementia and recent onset sick sinus syndrome presented to the ER following three episodes of syncope with post event confusion and somnolence. Two EEGs revealed focal slowing over the temporal regions. She was started on dilantin by the attending geriatrician because the EEGs had not ruled-out epilepsy.

Discussion

Our results are consistent with those obtained by Davis and Freemon[2] in a study of 99 EEGs between September 1987 and August 1989. They found 14% of EEGs were abnormal and only 1% had epileptic abnormalities, compared to 11% and 0% in our series (1.4% had potentially epileptic activity). In only one case reported by Davis and Freemon was there an important change in patient management although, as in our series, review of the chart did not clearly document seizures. More recently, Abubakr and Wambacq[5] presented a series of 1094 EEGs performed for syncope from January 1999 to December 2003. They found a higher percentage of abnormal EEGs (29%) but only 1.5% had epileptic abnormalities. None of the EEGs with epileptic abnormalities changed the management of their patients, although they did not provide any details and no data for the non-epileptic abnormalities.

Our results extend these prior observations by documenting the yield according to referring physician, and showing that EEGs ordered by neurologists do not have a higher yield. In fact, the yield of the EEG was higher if it was ordered by an ER physician or an internist when compared to neurologists. This difference can probably be explained by the fact that ER physicians and internists were more likely to be seeing hospitalized or ER patients, rather than out-patients. Such patients are prone to toxic or metabolic disturbances that can produce non-specific slowing on the EEG. Indeed, the abnormal EEGs requested by ER physicians and internists only revealed focal or generalized slowing, and not epileptic or potentially epileptic activity. The time to obtain an EEG for hospitalized or ER patients was also shorter (one day or less, compared to a median of 14 days for the study population as a whole). The yield of an EEG in epilepsy is higher when it is performed within 24 hours of the event[10], although as stated the higher yield for internists and ER physicians in our study related exclusively to slowing and not epileptic abnormalities.

The benefit of more appropriate EEG requisitions would be two-fold. Reducing the number of inappropriate EEGs requested for suspected syncope would lower the risk of misinterpretation of minor, non-significant abnormalities and inappropriate treatment of patients with anti-epileptic medication (such as may have occurred in one of our patients). In one study from a Canadian tertiary adult epilepsy clinic, 13% of patients were misdiagnosed as having epilepsy when they were in fact suffering from neurocardiogenic syncope[11]. Inappropriate treatment was instituted in 35% of cases, leading to hypersensitivity reactions (4.1%) and adverse pregnancy outcomes (5% of females)[11]. Moreover, one third of their patients had unnecessary restrictions placed on driving and employment[11]. More appropriate requisitions would also result in significant cost savings ($23 321.87 per year in our institution alone). Such a change in practice is feasible[12].

This study has some limitations. It was a retrospective study from a single institution. However, our institution is a tertiary care teaching hospital with active involvement in a large neurology residency training program. Therefore, we feel that our findings are representative of what would be found at other institutions. A second limitation is that our inclusion criteria consisted simply of patients referred for syncope, convulsive syncope, falls, or loss of consciousness. We did not analyze features of the patient's history or try to confirm the referring physician's diagnostic impression, nor did we compare the results with those patients referred for new onset seizures. A third limitation is the median time of two weeks to obtain an EEG. An EEG is more likely to be abnormal in patients with seizures if it is done within 24 hours of the event[10]. We cannot exclude the possibility that we would have found a greater number of abnormal EEG's if the median time was shorter. However, we did not find epileptic abnormalities even in the 17% of patients who did obtain an EEG within 24 hours. We also feel that the timing in our study is more realistic for clinical practice. Despite these limitations our data reveals a low yield of detecting epileptic abnormalities in patients with the clinical diagnosis of syncope, falls or unexplained loss of consciousness, regardless of the specialty of the referring physician. We believe that the simplicity of our inclusion criteria make our results clinically meaningful.

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