Evaluation of Patients Monitored in Long-term Video-electroencephalography: Clinical and Demographical Specificities with Management Implications

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Abstract

Objective: Long-term video-electroencephalography monitoring (LTVEM) is an invaluable technique to assess patients with epilepsy, specifically for differential diagnosis and managing drug-resistant epilepsy. LTVEM plays a crucial role in the surgical management of epilepsy. We aimed to determine the clinical and demographic specificity of patients monitored at the LTVEM unit and the optimal length of hospitalization to decide on management.

Methods: Demographic data, electrophysiological findings, seizure types, duration, latencies, length of stay, and treatment of 96 consecutive adult patients who were monitored at the LTVEM unit between August 2023 and February 2024 were retrospectively evaluated.

Results: We identified 49 (51%) epileptic patients, 34 (35.4%) non-epileptic patients, and 9 (9.4%) patients with coexistence of epilepsy and psychogenic non-epileptic seizure (PNES). The latency of the first PNES attack was shorter than that of the first epileptic attack. The mean seizure duration of patients diagnosed with PNES was longer than that of patients diagnosed with epilepsy. The mean latency time to first interictal epileptiform discharge (IED) in patients with generalized epilepsy was shorter than the mean latency time to first IED in patients with focal epilepsy. The mean length of stay of patients with focal epilepsy was significantly longer than that of patients with generalized epilepsy ($p<0.001$).

Conclusion: One-third of the patients monitored in our LTVEM unit were diagnosed with PNES. The latency of the first seizures of patients diagnosed with PNES was shorter than that of patients diagnosed with epilepsy, whereas the seizure duration of PNES was longer. It has been revealed that the first IED latency in patients with focal-onset seizures, and probably related to this, the length of hospital stay is longer than that in patients with generalized epilepsy. We believe that the current study may be helpful in planning the LTVEM unit hospitalization period and appointments for different types of seizure.

Keywords: Epilepsy, epilepsy surgery, long-term video electroencephalography, psychogenic non-epileptic seizures

INTRODUCTION

Although epilepsy is one of the oldest diseases of humans, it remains a challenging disease in terms of differential diagnosis.[1] Almost a century ago, the invention of electroencephalography (EEG) made it easier to determine whether a patient has epilepsy. Still, a much more important cornerstone was the invention of video recording and its use with EEG.[1]

Seizures are transient events rarely observed in the clinic or recorded on routine outpatient EEG; therefore, video recordings of events are a powerful extension of anamnesis because they may answer the questions in physicians' minds.[1] In addition, developing technologies, such as long-term video EEG monitoring (LTVEM), may be more helpful in differentiating epilepsy, determining the epileptogenic zone in the brain, and evaluating surgical aspects of epilepsy management.[2]

Although the number of LTVEM units has been increasing daily, there are still some difficulties and uncertainties in patient management, appointment protocols, and evaluation of patients' clinical and electrophysiological findings.[3]

In this study, we aimed to determine the clinical and demographic characteristics of patients monitored at the LTVEM unit and the optimal duration of hospital stay required to diagnose and decide on treatment as medical, surgery, or none.

METHODS

We retrospectively analyzed all 96 patients monitored at the LTVEM unit of a tertiary healthcare center between August 2023 and February 2024. Clinical information including gender, age, age at diagnosis, indication for LTVEM unit referral, length of hospital stay, interval between the last seizure and LTVEM recording, latency to the first interictal epileptiform discharge (IED), latency to epileptic or non-epileptic seizure, duration and number of seizures during LTVEM, frequency of seizure in daily life, and anti-seizure medication (ASM) were recorded.

All EEGs were performed using a 32-channel video EEG (Micromed Sd ltm 128) according to the international 10-20 system. Standard bipolar montage and other montages were used.

Patients underwent LTVEM for differential diagnosis, localization of seizure focus, or defining therapy [medical, vagal nerve stimulation (VNS), or epilepsy surgery].

ASM were gradually decreased by one-third of the total daily dosage. If the patient had frequent and/or nonamenable seizures, the ASM was not changed, or dose reduction was performed more slowly.

Imaging findings were classified as localized encephalomalacia, focal cortical dysplasia, mesial temporal sclerosis, pachygyria, tumor, or non-specific findings (Table 1).

Patients' seizure types were classified as epileptic, psychogenic non-epileptic seizure (PNES), and mixed (both epileptic and non-epileptic) by three neurologists (one epileptologist, one clinical neurophysiologist, and one specialist) according to the International League Against Epilepsy 2017 classification.

The study was approved by the Local Ethics Committee of Ankara Etlik City Hospital (decision no: AEŞH-BADEK-2024-076, date: 06.03.2024).

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 26.0 (IBM Corporation, Armonk, NY, USA). Descriptive analyses were presented using numbers, percentages, medians, and minimum-maximum range. Shapiro-Wilk test was used to determine whether the variables were normally distributed. The Mann-Whitney U test was used to compare non-parametric data between two independent groups, and the Kruskal-Wallis test was used to compare three or more independent groups. The relationships between variables were evaluated using Spearman's correlation tests. A p value 0.05 was considered statistically significant. Figures and tables were created using Microsoft Word 2010 and SPSS.

MAIN POINTS

- Referral delays (15.74 years in this study) for patients with epilepsy to tertiary centers significantly postpone surgical evaluations, underscoring the need for earlier referrals.
- A 5-day follow-up period in long-term video electroencephalography monitoring (LTVEM) units is sufficient, supporting the recommendation to align appointment scheduling with this timeframe to ensure clarity and efficiency.
- Six of our nine patients with coexisting psychogenic non-epileptic seizure (PNES) and epilepsy experienced a PNES episode followed by an epileptic seizure, highlighting the need for careful decision-making in cases with PNES.
- We did not diagnose epilepsy in approximately one-third of our patients, and approximately one-fifth of these were followed with a diagnosis of drug-resistant epilepsy (DRE), highlighting the importance of considering PNES in the differential diagnosis of DRE.

RESULTS

The mean age of all patients was 35.83±11.146 years (range, 20-64 years), 56 patients were women (58.3%), and the mean time since diagnosis was 15.74±13.361 years. 83.3% of patients (n=80) had previously been diagnosed with epilepsy. 26.0% (n=25) of patients had been receiving monotherapy, and 51.0% (n=49) had been receiving polytherapy. Twenty-one patients were untreated (Tables 1, 2).

The indication for hospitalization for 50% (n=48) of patients was differential diagnosis (whether the patient has epilepsy or not), for 15.6% (n=15) to determine the epileptogenic zone, and for 34.4% (n=33) to decide the treatment modality (Table 1).

Fifty-eight patients were diagnosed with epilepsy; 13 patients had generalized-onset epilepsy and 41 with focal-onset epilepsy. We did not observe epileptic seizures or note interictal discharges during LTVEM in 3 out of the remaining 4 patients; however, based on the seizure videos recorded outside the hospital, we considered the diagnosis of epilepsy. It could not be determined whether the seizures of the remaining patient had a focal or generalized onset.

Thirty-four patients had PNES, but 9 of them had both epileptic and non-epileptic seizures. In 4 of the 96 patients, we identified pathologies such as syncope, which is attributed to cardiac etiology (n=1) and parasomnia (n=1), rather than epilepsy or PNES. No pathological findings were identified in the LTVEM recordings of the remaining patients.

Neuroimaging studies are summarized in Table 1. One patient did not undergo any cranial imaging.

The mean duration of LTVEM was 4.81±2.221 day (range, 1-11), and the duration was shorter in the generalized epilepsy group compared with the focal epilepsy group ($p<0.05$). The focal epilepsy group showed a positive correlation between the latency of the first IED and the latency of the first seizure and also the duration of VEM. However, findings regarding the latency of the first IED showed no significant difference according to epileptic localization (generalized or focal) ($p>0.05$) (Table 3).

A correlation analysis was conducted to determine the relationship between the duration of hospitalization (days), total number of PNES attacks, and total number of epileptic seizures during the LTVEM process (Table 4). There was no significant relationship between the duration of hospitalization and the total number of attacks or seizures ($p>0.05$).

Our study showed that 35.4% (n=34) of all patients did not require epilepsy treatment, and 7 (20.5%) of these patients had previously been followed up with refractory epilepsy or drug-resistant epilepsy (DRE).

Table 1. Descriptive findings related to nominal data

		n	%
Gender	Female	56	58.3
	Male	40	41.7
Diagnosis of epilepsy	Yes	80	83.3
	No	16	16.7
Indication for hospitalization	Epileptic/non-epileptic differentiation	48	50.0
	Determining epileptic localization	15	15.6
	Determining treatment	33	34.4
Appropriate treatment	Medical	39	40.6
	Vagal nerve stimulation	11	11.5
	Surgery	10	10.4
	No epilepsy treatment	34	35.4
	Invasive EEG	2	2.1
Radiological findings	Normal MRI/non-specific findings	62	64.6
	Localized encephalomalacia	12	12.5
	Focal cortical dysplasia	4	4.2
	Mesial temporal sclerosis	13	13.5
	Pachygyria	1	1.0
	Tumor	2	2.1
	Cerebral hemiatrophy	1	1.0
Diagnosis of LTVEM	Epilepsy	49	51.0
	PNES	34	35.4
	Epilepsy+PNES	9	9.4
Treatment received before LTVEM	Monotherapy	25	26.0
	Polytherapy	49	51.0
	No treatment	21	21.9
Epileptogenic localization	Focal	41	42.7
	Generalized	13	13.5

EEG: Electroencephalography, LTVEM: Long-term video EEG monitoring, PNES: Pshycogenic non-epileptic seizure, MRI: magnetic resonance imaging

Table 2. Descriptive findings regarding continuous variables

	Min	Max	Mean	SD	Median
Age (years)	20	64	35.83	11.146	34
Duration of epilepsy	1	55	15.74	13.361	13
Length of hospital stay (days)	1	11	4.81	2.221	5
Time from first non-epileptic seizure during LTVEM (hours)	1	124	28.79	35.655	13
Time from first epileptic seizure during LTVEM (hours)	1	162	49.17	47.882	24
Time from first interictal epileptiform discharge during LTVEM (minutes)	1	6000	448.17	1120.654	79
Total number of seizures during LTVEM	0	19	2.95	3.712	2
Total number of non-epileptic seizures during LTVEM	0	14	0.71	1.886	0
Total number of epileptic seizures during LTVEM	0	19	2.24	3.600	0
The shortest seizure duration (seconds)	3	1200	69.91	164.881	37.5
The longest seizure duration (seconds)	6	1206	151.47	228.195	80
Avarage seizure duration (seconds)	6	1203	104.00	179.785	58.5
Time between last seizure and LTVEM admission (days)	1	3650	89.44	395.442	10

SD: Standard deviation, LTVEM: Long-term video electroencephalography monitoring, min: Minimum, max: Maximum

Table 3. Differences in time from epileptic localization to first interictal epileptiform discharge during LTVEM

	Epileptic localization	n	Mean	SD	Mean rank	Z	p
Time to first interictal epileptiform discharge during LTVEM (minutes)	Focal	41	390.00	910.780	28.54	-1.876	0.061
	Generalized	11	151.91	380.084	18.91		

SD: Standard deviation, LTVEM: Long-term video electroencephalography monitoring

Table 4. Correlation analysis results between hospital stay length and total number of non-epileptic and epileptic seizures during LTVEM

		Total number of non-epileptic seizures during LTVEM	Total number of epileptic seizures during LTVEM
Length of hospital stay (days)	r	-0.030	0.117
	p	0.772	0.255

LTVEM: Long-term video electroencephalography monitoring

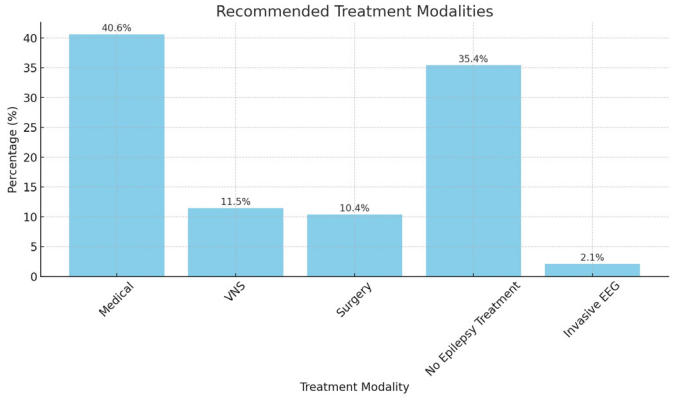

Figure 1. Treatment modalities based on LTVEM results

EEG: Electroencephalography, LTVEM: Long-term video EEG monitoring, VNS: Vagal nerve stimulation

VNS was deemed appropriate for 11.5% (n=11) of the patients, and LTVEM recorded with scalp electrodes was insufficient in 2 patients, so invasive EEG was considered. The treatment modalities proposed are detailed in Figure 1. Epilepsy surgery was indicated for 10.4% (n=10) of the patients, but according to the interdisciplinary joint session results, invasive EEG was proposed for five of the patients.

DISCUSSION

One of the key findings of this study is that referral of epilepsy patients to tertiary centers is delayed because we determined that the time elapsed from the time of diagnosis was 15.74 years (range, 1-55). Therefore, surgical evaluation of these patients is still being delayed. In studies conducted in developing countries where patients who underwent epilepsy surgery were scanned retrospectively, an average waiting time of 18.9,[4] 23,[5] and 20-21[6] years was observed. In contrast, studies from industrialized countries have shown shorter times, ranging from 10.4[5] to 16.9[4] years. Because earlier surgery can prevent significant morbidity and premature death,[7] it is crucial to encourage physicians from secondary healthcare centers, as well as patients with epilepsy, to refer to tertiary centers for surgical consideration.

Previous studies on the optimal duration of LTVEM showed conflicting results because of disparities across studies; however, in our study, approximately 5 days (4.81±2.221) were found to be sufficient for patients followed in the LTVEM unit, and this finding is consistent with studies reporting heterogeneous groups of patients.[8-10] In regions like our country, where centralized appointment systems are used, scheduling appointments for LTVEM patients at intervals of 5 days is recommended to prevent confusion. However, patients are not advised to adhere strictly to the 5-day rule because shorter or longer hospitalization periods may be necessary.

It is well known that the differential diagnosis of epilepsy and PNES continues to challenge physicians[11] and this differential diagnosis is crucial, as a misdiagnosis can lead to unnecessary medication for patients with PNES and may leave epilepsy patients untreated. It is evident that this can result in unintended consequences, such as unnecessary drug side effects, increased economic burden, leaving the epilepsy patient without treatment, and even death (e.g., SUDEP). In routine practice, we aim to make diagnostic decisions after observing an average of 3 seizures in our patients during LTVEM (average number of total seizures during LTVEM: 2.95±3.712). However, in this study, PNES episodes were observed less frequently than epileptic seizures (0.71±1.886 vs. 2.24±3.600). Although Foong and Seneviratne[10] found that PNES episodes occur later, our study showed that PNES patients experience seizures earlier during the LTVEM process compared with epilepsy patients. (28.79±35.655 vs. 49.17±47.882 hours). The coexistence of PNES and epilepsy is not negligible according to our study (9.4%, n=9 patients had PNES and epilepsy) and literature.[11,12] Another point is that 6 of 9 patients with mixed seizures had experienced PNES before epileptic seizure during LTVEM. Therefore, we suggest not rushing the discharge of LTVEM patients who experience a PNES episode.

As mentioned in the literature, identifying PNES constitutes a clinical challenge. For example, Sanabria-Castro et al.[13] concluded that 12.8% of the DRE patients had PNES, moreover up to 50% of patients referred to an epilepsy center for VNS with a diagnosis of DRE were actually diagnosed with PNES in the study by Benbadis et al.[14] In our study, similar to the literature, the number of patients who were previously diagnosed with DRE but were later found to have been misdiagnosed and did not require epilepsy treatment after LTVEM was not inconsiderable. According to the results of our study, no epilepsy was detected after LTVEM in 34 patients, however 7 of whom (20.5%) were followed up with a diagnosis of DRE previously.

The results of studies on the latency of the first IED in LTVEM patients are contradictory in the literature. Although some studies have found no difference between focal and generalized epilepsy,[15,16] others have shown that IEDs emerge earlier in generalized epilepsies.[17] In our study, the difference in the latency to the first IED between focal and generalized epilepsies was not significant (Table 3). The small sample size might be the reason for this. Although there was no significant difference in IED latencies, the average length of hospital stay for focal epilepsy patients was longer than that for those with generalized epilepsy. The possibility that focal epilepsy patients may be candidates for surgical treatment necessitated more careful and extended evaluations. Additionally, in some patients, the need for additional radiological imaging [such as functional magnetic resonance imaging (MRI), MRI corticography, or positron emission tomography] may have prolonged this duration.

Approximately 20% of the patients analyzed (10 requiring VNS, 12 requiring surgery and/or invasive investigations) required advanced treatment modalities, and when patients with PNES were excluded, this rate increased to nearly one-third. Moreover, our study, while slightly lower than non-selective studies in the literature,[18,19] demonstrated that approximately one-third of the patients were diagnosed with PNES, further underscoring the significance of LTVEM.

Study Limitations

The limitations of this study include its retrospective design and small sample size. To enhance our understanding of LTVEM and optimize patient management, future research should focus on larger-scale, prospective studies.

CONCLUSION

In conclusion, our study highlights the significance of LTVEM by demonstrating a high rate of diagnostic changes before and after LTVEM. Additionally, this study may provide valuable insights into the duration of LTVEM hospitalization for different seizure types and assist in scheduling or appointment planning for LTVEM units.

Ethics

Ethics Committee Approval: The study was approved by the Local Ethics Committee of Ankara Etlik City Hospital (decision no: AEŞH-BADEK-2024-076, date: 06.03.2024).

Informed Consent: Retrospective study.

Presented in: This study was presented as an oral presentation at the 14th National Epilepsy Congress on May 18, 2024.

Footnotes

Authorship Contributions

Surgical and Medical Practices: İ.K., M.Y., A.E.Ç., Concept: İ.K., A.E.Ç., Design: İ.K., M.Y., A.E.Ç., Data Collection or Processing: İ.K., M.Y., Analysis or Interpretation: M.Y., A.E.Ç., Literature Search: İ.K., Writing: İ.K., A.E.Ç.

Conflict of Interest: No conflict of interest was declared by the authors.

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