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Factors Contributing to the Length of Stay in Patients Admitted to the Epilepsy Monitoring Unit

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Abstract

Electroencephalography with video monitoring (VEEG) is considered the gold standard for differentiating epileptic from non-epileptic events. The standardization of length of hospital stay (LOS) in the Epilepsy Monitoring Unit (EMU) setting is challenging due to the paroxysmal nature of seizures. This study evaluates the factors contributing to the LOS and days of VEEG recording with the EMU final diagnosis and plan. A retrospective study was conducted on inpatients admitted to the EMU, at a tertiary center from January to December 2016. All consecutive patients admitted to EMU during the study period were included. A total of 160 patients were enrolled. The mean age was 21.10 years (SD 13.33). Upon discharge, most of the patients were diagnosed with epileptic seizures, of whom 91 (56.9%) had focal seizures, and 30 (18.8%) had generalized epilepsy. Patient who stayed in the EMU>12 days required 6-10 days of VEEG recording to reach the diagnosis. Patients who had the surgical plan as a discharge diagnosis were significant to have a prolonged length of stay>12 days. Six to ten days of EEG recording were significant to diagnose focal seizures in 44 (60.3%). Patients were concluded to have a surgical plan (resective surgery), focal seizures and Attention Deficit Hyperactivity Disorder (ADHD) as a comorbidity are all significantly associated with a prolonged length of stay. Our findings suggest that factors affecting the length of hospital stay or period of EEG recording during the admission should be considered when planning EMU admissions.

Keywords: Epilepsy monitoring unit; Length of stay; EMU; Prolonged hospitalization; EEG monitoring.

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Introduction

Electroencephalography with video monitoring (VEEG) is a non-invasive diagnostic tool that is considered the gold standard for differentiating epileptic from non-epileptic events. VEEG also helps in seizure classification and pre-surgical evaluation for drug-resistant epilepsy [1]. A seizure is defined as a transient event that occurred due to an abnormal excessive or synchronous neuronal activity in the brain tissues [2]. However, epilepsy is an underlying pathological tendency to have recurrent seizures [3]. The clinical tool for evaluating patients with epilepsy is seizure classification, it serves in multiple clinical and research domains. It can be evaluated through the VEEG, which will help to understand the types of seizure, potential triggers, and identify the associated comorbidities, such as learning difficulties, intellectual disabilities, and psychiatric manifestation as depression and anxiety through neuropsychology evaluation. Addition comorbidities include the mortality risk as a sudden unexpected death in epilepsy (SUDEP). Further, therapeutic plan as antiepileptic drug (AED) adjustment, epilepsy surgery, or immunotherapy, as well as the prognosis. Indeed, before classifying seizures, a clinician must determine if these paroxysmal events are epileptic seizures or non-epileptic events as psychogenic non-epileptic seizures (PNES), convulsive syncope, parasomnias, movement disorders, or cardiac syncope [4]. The International League Against Epilepsy (ILAE) defined drug-resistant epilepsy (DRE) as failure to achieve seizure freedom by trials of two well-chosen and tolerated AEDs either as monotherapy or in combination [5]. The majority of patients with DRE or non-epileptic events had a definitive diagnosis after their

EMU admission, which either confirmed or changed the previous diagnosis and was managed accordingly [5].

The standardization of length of hospital stay (LOS) for epilepsy patients in the EMU setting is challenging due to the paroxysmal nature of seizures [6]. In the fiscal year 2014, the mean LOS for epilepsy cases admitted to EMU was between 3.3-5.7 days [3]. It was reported that the average days of having the first event/seizure ranged from one to two days [7,8]. The mean LOS for monitoring with VEEG was five days, while 35% of patients who needed three or more days [7]. It was reported the average LOS in an EMU was around 3-4 days for adults, compared to 1.2-1.5 days for pediatric stays [9]. LOS can be longer for patients with pre-surgical evaluation (mean 3.5 days) than PNES patients admitted for spells classification of 2.4 or fewer days [8,10,11].

To the best of our knowledge, some studies evaluate the length of stay at the epilepsy monitoring unit with different factors. However, there are no studies that assess the days of VEEG recording with the final diagnosis and plan. This study evaluates the factors contributing to the LOS and days of VEEG recording with the EMU final diagnosis and plan. Furthermore, the study also evaluate other contributing factors such as patients' age group, epilepsy risk factors, event classification (epileptic vs. non-epileptic), number of AEDs, completion of phase I pre-surgical evaluation, and complications related to admission.

Materials and Methods

Study design and population

A retrospective study was conducted on inpatients admitted to the Epilepsy Monitoring Unit (EMU) at King Faisal Specialist Hospital and Research Center in Riyadh, a tertiary and referring center for most drug-resistant epilepsy cases in the Gulf's countries, from January 2016 to December 2016. All consecutive patients admitted to the EMU during the study period were enrolled.

Data collection

Before conducting the study, ethical approval was obtained from the Institutional Review Board (IRB) at King Faisal Specialist Hospital and Research Center (KFSHRC) (# 2171 160).

Data were collected from the epilepsy monitoring unit and epilepsy conference reports for all patients who were monitored with continuous video scalp EEG or subdural (SD) EEG to localize/lateralize their seizures/events. Patients were admitted to our EMU for either seizure classification or pre-surgical evaluation.

Variables

Our dependent variables were the length of stay (LOS) which is the total days of hospital admission in the EMU, and days of EEG recording, which is the number of days patients were connected to video monitoring EEG. Both were measured in days. A value of 0 was possible when the patient was discharged on the same day as admission for a certain reason that will be mentioned in detail. For patients with LOS >7 days, we recorded the reasons contributing to prolonged LOS.

Data abstracted from the medical records included:

- Clinical and demographic data: age (based on our hospital criteria for EMU admission - population divided into pediatric from 1-15 years and adult), gender, age of onset, seizure frequency per month, risk factors, comorbidity (Intellectual disability (ID), Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), Visual/Hearing impairment), and city of residence.
- Reasons for admission: seizure classification (Epileptic or Non-epileptic "PNES or non-epileptic events related to cardiac causes; syncope"), pre-surgical evaluation for generalized vs. focal seizures, localization (temporal, temporal plus, extra-temporal), surgical plan (surgical "resective vs. palliative", non-surgical "optimizing medical therapy or immunotherapy").
- Reasons for prolonged admission: first seizure timing, number of AEDs, and complications (hospital-acquired infections, musculoskeletal pain, falls, skin abrasions, or SUDEP).
- EMU protocol: activation procedure (hyperventilation, photic stimulation, and sleep deprivation), hygiene break, and all types of semiology were recorded.
- Others: previous admission, type of monitoring (scalp/SD), investigation performed during admission, and season (month of admission).

EMU Protocol

The EMU at KSFSHRC is considered as one of the largest referring epilepsy centers in the Gulf's countries. In addition, it is the first referring center accepting drug-resistant epilepsy cases from the whole kingdom. It consists of a 6-bed unit integrated into the general neuroscience floor for both adult and pediatric cases. Eight full-time board-certified staff adult/pediatric epileptologists rotate through the EMU with five full-time fellows. Four board-certified EEG technologists are responsible for the technical aspects of the EMU and other hospital duties and are on call 24 hours a day. Patients admitted to the EMU underwent continuous digital video-EEG monitoring throughout their EMU stay.

- Patient and family assessment and education: before or upon admission, patients must sign informed consent specific to procedures and care in an EMU, including the use of video monitoring and care specific to the seizure provocation during EEG monitoring in the EMU.
- Preparation for EMU admission: chart review for phase I pre-surgical evaluation including: three-tesla Magnetic Resonance Imaging (MRI) of the brain, functional Magnetic Resonance Imaging (fMRI), Magnetoencephalography (MEG), Positron Emission Tomography (PET) scan, Single-Photon Emission Computed Tomography (SPECT), neuropsychology assessment and sodium amobarbital procedure WADA test if needed. These tests are conducted before the admission and individualized to each patient

to facilitate the completion of the required tests either during the admission or as an outpatient.

- Seizure precautions: EMU staff implement seizure precautions as clinically indicated and provide seizure first aid for all seizure types. Strategies include at a minimum: a) monitor changes in consciousness, mental status, and behaviors, b) monitor vital signs during acute seizures, during and after administration of IV AEDs, and as clinically indicated c) turn patient on their side as soon as possible and support head to help keep open airway (for generalized seizures), d) have suction and oxygen available, e) use padded side rails, f) assess patient frequently after the event until they return to the baseline, while monitoring the time length of event and documenting observations.
- Seizure observation: continuous observation is needed at all times for all patients during EEG monitoring by the nursing staff with the presence of the patient's sitter. The use of additional cardiac monitoring and pulse oximetry to assist with diagnostic testing and safety is used when appropriate.
- Response to acute seizures: EMU staff must have immediate access to emergency medications, including IV preparations of AEDs, to treat seizure emergencies. Each patient should have an individualized plan for managing acute seizures based on the reason for admission, seizure history, the risk for seizure emergencies, medication history, and other pertinent information. EMU staff consider medications based on the need for short-term suppression or long-term treatment of seizures. Physicians can manage seizure emergencies available in-house to EMU 24 hours a day. Intravenous access or alternative drug administration methods should be established at the beginning of the monitoring period in all patients.
- AED tapering: patients generally undergo processes such as AED tapering to help capture seizures. The subsequent tapering of AEDs is not uniform; rather, tapering is individualized for each patient based on factors such as baseline seizure frequency, history of status epilepticus, and medication half-life.
- Activity and environment: personnel in monitoring units should assess their environment to optimize patient safety and include: a) bed and chair alarms, b) safe waiting area for use before admission or discharge, c) a typical activity and safety plan including: plans for travel off the EMU if clinically indicated, and d) out of bed with assistance only.
- Discharge planning: consider the time of the last seizure, generally ensuring that patients have been seizure-free for 24 hours before discharge. Discharge teaching should include: a) AED changes that occurred during the monitoring period and medications to be taken after discharge, b) when to contact their epileptologist for changes in seizures, behavior or mood, c) how to manage seizures after discharge, including use of rescue or PRN medications for temporary treatment of seizures if clinically indicated, d) timing of follow-up appointments, and f) safety precautions, activity limitations when to resume normal activity.

Statistical analysis

The data were coded and analyzed via Statistical Package for the Social Sciences (SPSS, version 25.0, Chicago, IL) software. The descriptive analysis was presented in mean and standard deviation for continuous variables, whereas categorical variables were described using frequencies and percentages. Additionally, Chi-square tests were used to assess the association between the outcome and categorical independent variables. Independent student t-test and one-way ANOVA were used for comparing two and more means, respectively. The significance level was set at less than 0.05 at a confidence interval of 95%.

Results

Clinical and demographic characteristics

A total of 160 patients were enrolled in the study-designated period. **Table 1** shows descriptive clinical and demographic findings in participants. The mean age was 21.10 years (SD 13.33), in which the highest percentages were aged less than 15 (36.3%). Males represented 52.5% of the participants, while females represented 47.5%. Only 20% of patients were from Riyadh. Autumn and spring were the peak seasons of EMU admission cases. Almost half of the participants had three AEDs (45%). The comorbidities evaluated in our population were visual impairment, hearing impairment, autism, ADHD, intellectual disability and psychiatric comorbidities, in a frequency of 2 (1.3%), 3 (1.9%), 3 (1.9%), 14 (8.8%), 39 (24.4%), and 19 (11.9%), respectively. Eleven patients experienced complications during EMU admission, four patients (2.5%) had hospital-acquired pneumonia, two had skin abrasion (1.3%), two had autoimmune flare-up (1.2%), one had aspiration pneumonia secondary to status epilepticus (0.6%), one had near-SUDEP (a patient with epilepsy who survives resuscitation for more than an hour after cardiorespiratory arrest and has no structural cause identified after investigation), and 1 had shoulder dislocation due to generalized tonic clonic seizures (GTC). Patients admitted for pre-surgical evaluation were 105 (65.6%). The remaining patients were admitted for classification 55 (34.4%). The majority of monitoring types were scalp EEG which accounted for 149 patients (93.1%), of those patients, 44 (8%) stayed for more than 12 days, whereas invasive subdural monitoring accounted for 11 patients (6.9%), of them, 6 patients (12%) stayed more than 12 days.

Upon discharge, most of the patients were diagnosed with epileptic seizures, of whom 91 (56.9%) had focal seizures, and 30 (18.8%) had generalized epilepsy. The seizure localization for focal epilepsy were extra-temporal (ET) 40 (25%), Temporal (T) 39 (24.4%), and temporal plus (T+) 14 (8.8%). The second group was diagnosed with non-epileptic events, divided into psychogenic non-epileptic seizures (PNES) 20 (12.5%) and non-epileptic events related to cardiac causes (syncope) 3 (1.9%). The remaining

Table 1 Demographic characteristics for our sample.

N (%) 160 (100%)	
Age (year) mean=21.10 years (SD=13.33)	
1-15	58 (36.6)
16-24	45 (28.1)
25-34	33 (20.6)
35-45	18 (11.3)
Above 45	6 (3.8)
Age of Onset (year)	
0-2	44 (27.5)
2-14	89 (55.6)
15-35	23 (14.4)
Above 35	4.0 (2.5)
Seizure frequency (month)	
Below 5	48 (30)
5-10	20 (12.5)
11-21	26 (16.3)
Above 21	66 (41.3)
Gender	
Male	84 (76)
Female	76 (47.5)
Risk Factor (92) 57.5	
Febrile seizure	14 (8.8)
Family history	36 (22.5)
Head trauma	19 (11.9)
CNS infection	11 (6.9)
Pre-Peri-Post natal-complication	21 (13.1)
Developmental delay	42 (26.3)
Comorbidity (61) 38.1	
Psychiatric disorder	19 (11.9)
Autistic spectrum disorder	3 (1.9)
ADHD	14 (8.8)
Hearing impermeant	3 (1.9)
Visual impermanent	2 (1.3)
Intellectual disability	39 (24.4)
Reason of Admission	
Classification	55 (34.4)
Pre-Surgical	105 (65.6)
Previous Admission	32 (20)
Re-do surgery	4 (2.5)
Type of recording	
Scalp	149 (93.1)
Subdural	11 (6.9)
City	
Riyadh	32 (20)
Out-side Riyadh	128 (80)
Season	
Spring	43 (30.6)
Summer	29 (18.1)
Autumn	49 (30.6)
Winter	39 (24.4)

patients were non-conclusive due to the following reasons: 10 (6.3%) of patients had no seizures during the period of admission, 3 (1.9%) were not connected to EEG due to hair lice, 2 (1.3%) were discharged DAMA due to social reasons, 1 (0.6%) was not cooperative for EEG recording as he had a combined type of (ADHD). Seven patients who presumed to have epileptic seizures and discharged as PNES **(Figure 1)**. In addition, 19 patients were admitted for pre-surgical evaluation and ended by palliative therapy VNS (11), colostomy (3), functional hemispherectomy (4), and radio ablation therapy (1). Resective surgery was performed for 76 patients; intracranial EEG was planned for 29 patients, 45 subjects directed for resective surgeries, medication was adjusted for 1 patient when the resective surgery failed, and 1 underwent gamma knife for hypothalamic hamartoma (HH). The mean length of stay in EMU for our population was 11.12 days (SD 6.45), and the mean for EEG recording days was 6.46 (SD 3.72).

Factors associated with the number of EEG recording days and Length of Stay (LOS) days

Tables 2 and 3 show the factors associated with prolonged days of EEG recording and length of hospital stay at EMU. More than 7 days at EMU and more than 6 days of VEEG recording were considered as prolonged. There was no significant difference in both lengths of stay and EEG recording days in the proportion based on gender.

The pediatric age group tended to have longer EMU admission: > 12 days in 18 patients (36.0%). Patients with earlier age of epilepsy onset between 2-14 years, had EEG recording ranged 6-10 days. Patient who stayed in the EMU >12 days required 6-10 days of video EEG recording to reach the diagnosis (p-value <0.001). Patients who had the surgical decision as a discharge diagnosis were statistically significant to have a prolonged length of stay >12 days (p-value 0.003) as shown in **Table 4A**. Six to ten days of EEG recording were statistically significant (p-value 0.003) to diagnose focal seizures in 44 patients (60.3%). In addition,

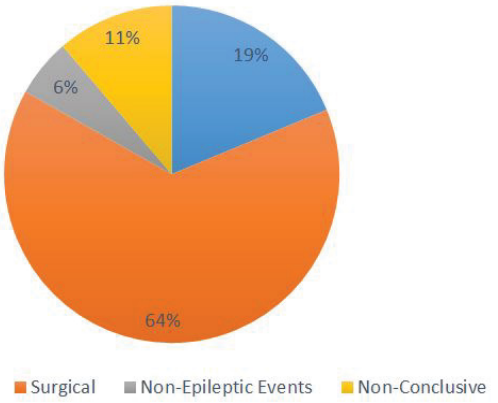

Figure 1 Showed the final EMU plan. EMU plan was divided into surgical (resective *vs*. palliative), non-surgical (medication adjustment/immunotherapy), non-epileptic events (PNES vs. non-epileptic events related to cardiac causes "syncope"), or non-conclusive due to discharge against medical advice (DAMA), no-seizure recorded during EMU stay, hair lice, or not cooperative patient. The majority of our EMU patients concluded to have a surgical plan.

Table 2 Factors contributing to the length of stay in epilepsy patients at EMU. This table illustrates the factors that contribute to prolonged EMU stay and showed the longest stays in patients who had to complete phase I investigations including (MRI, PET scan, fMRI, MEG, SPECT, and neuropsychology assessment).

Variables	Length of stay (LOS) n (%)					p-value
	1-3	4-6	7-9†	10-12†	>12†	
Reason for prolonged admission						
Complications	0 (0)	2 (7.1)	4 (9.8)	2 (6.5)	3 (6.0)	
Consultations	0 (0)	0 (0)	2 (4.9)	2 (6.5)	1 (2.0)	
Delayed EEG recording	2 (20.0)	1 (3.6)	2 (4.8)	0 (0)	0 (0)	
Investigation	4 (40.0)	6 (21.4)	12 (29.3)	11 (35.5)	14 (28.0)	
No seizure recorded	0 (0)	2 (7.1)	1 (2.4)	0 (0)	0 (0)	0.091
Number of waiting days	0 (0)	1 (3.6)	5 (12.2)	2 (6.5)	3 (6.0)	
Observation after resuming ADEs	4 (40.0)	11 (39.3)	7 (17.1)	6 (19.4)	12 (24.0)	
Outside Riyadh -Flight	0 (0)	4 (14.3)	4 (9.8)	3 (9.7)	3 (6.0)	
Surgery done	0 (0)	1 (3.6)	3 (7.3)	2 (6.5)	11 (22.0)	
To record more seizure	0 (0)	0 (0)	1 (2.4)	3 (9.7)	3 (6.0)	

One-way ANOVA test was used to compare the variables.
† Patient who are under these subgroups considered to have prolonged LOS days.

Table 3 Factors contributing to the prolonged days of EEG recording in epilepsy patients at EMU. This table illustrates the factors that contribute to prolonged days of EEG recording in epilepsy patient at EMU. It shows that majority of patients stayed between 6-10 days on EEG recording to capture the first seizure between 1-3 days, to have sleep deprivation, to do activation procedure, and to get one hygiene break.

Variables	Days of EEG Recording n (%)					p-value
	0	01-May	6-10†	11-15†	16-20†	
Reason for prolonged days of EEG recording						
Number of seizures recorded						
0-10	3(75.0)	38 (59.4)	51 (69.9)	10 (66.7)	3 (75.0)	
11-20	0 (0)	11 (17.2)	10 (13.7)	3 (20.0)	0 (0)	0.886
21-30	0 (0)	2 (3.1)	0 (0)	0 (0)	0 (0)	
31-40	0 (0)	1 (1.6)	1 (6.7)	1 (6.7)	0 (0)	
>40	1 (25.0)	12 (18.8)	1 (6.7)	1 (6.7)	1 (25.0)	
Timing of the 1st seizure						
1-3	1 (25.0)	52 (81.3)	55 (75.3)	11 (73.3)	3 (75.0)	
4-6	0 (0)	4 (6.3)	6 (8.2)	2 (13.3)	1 (25.0)	**0.039***
7-9	0 (0)	1 (1.6)	2 (2.7)	2 (13.3)	0 (0)	
10-12	0 (0)	2 (3.1)	0 (0)	0 (0)	0 (0)	
>12	0 (0)	0 (0)	1 (1.4)	0 (0)	0 (0)	
Number of AEDs						
0	0 (0)	1 (1.6)	1 (1.4)	0 (0)	0 (0)	
1	0 (0)	6 (9.4)	6 (8.2)	1 (6.7)	1 (25.0)	
2	2 (50.0)	17 (26.6)	19 (26.0)	2 (13.3)	2 (50.0)	0.403
3	1 (25.0)	25 (39.1)	36 (49.3)	10 (66.7)	0 (0)	
4	1 (25.0)	14 (21.9)	9 (12.3)	2 (13.3)	0 (0)	
5	0 (0)	1 (1.6)	2 (2.7)	0 (0)	1 (25.0)	
Sleep deprivation	0 (0)	33 (51.6)	**55 (75.3)**	12 (80.0)	3 (75.0)	**0.000***
Activation procedure	0 (0)	60 (93.8)	**68 (93.2)**	15 (100)	4 (100)	**0.000***
Hygiene break	0 (0)	1 (1.6)	**44 (60.3)**	15 (100)	3 (75.0)	**0.000***
Number of hygiene break						
1	0 (0)	(1) 1.6	**(43) 58.9**	(1) 6.7	0 (0)	
2	0 (0)	0 (0)	(1) 1.4	(13) 86.7	2 (50.0)	**0.000***
3	0 (0)	0 (0)	0 (0)	(1) 6.7	1 (25.0)	
NA	(4)100	0 (0)	0 (0)	0 (0)	0 (0)	

*Statistically significant value (p<0.05)
One-way ANOVA test was used to compare the variables.
† Patient who are under these subgroups considered to have prolonged VEEG recording days

patients who had non-conclusive diagnoses were statistically significant (p-value<0.001) for the same duration as shown in **Table 4B**. The maximum number of non-conclusive group was in no-seizure recorded subgroup by 4 patients (5.5%). The correlation between the timing of first recorded seizure during EMU admission and the total days of VEEG recording; the first seizure was occurred between 1-3 days of the beginning of the record and was statistically significant to total VEEG recording of 6-10 days (p-value 0.039). In our sample, 36 patients (49.3%) were on three AEDs and stayed on EEG recording for 6-10 days.

The LOS of > 12 days was statistically significant for the 35 patients who had been undergone resective surgery (70.0%) in comparison to palliative surgery. A total of 42 patients (84%) with epileptic seizures had prolonged length of stay >12 days compared to 8 patients (19.5%) who had non-epileptic events who stayed for 7-9 days **(Tables 4A and 4B)**. The comorbidities evaluated in our population compared to the LOS showed that the majority of stays were more than 12 days, and were statistically significant with ADHD (p-value 0.004). Psychiatric subgroups included 5 patients with depression (stayed 6-10 days), 5 with conversion (stayed from 6-15 days), 1 with anxiety (stayed 12 days), and 2 with psychosis (stayed 5-6 days).

Factors that contributed to prolonged LOS during EMU admission included: EEG was not connected from the first day of admission, no seizure recorded during their stay, to record more of the habitual seizures, presence of complications, consulting other services, observation after resuming AED, completion of phase I investigation, a surgical procedure performed during the same admission, or patients from outside Riyadh. For patients who experienced issues upon admission that interfered with reaching conclusive data such as hair lice, no seizure recorded during their stay, discharged DAMA, or not cooperative for connection; the LOS was between 0-15 days. Completing phase I investigations was the major cause of the prolonged stay for more than 12 days in 14 patients (28.0%), followed by resuming or adjusting AEDs in 12 patients (24.0%). Investigations included the following: MRI brain (47 patients, 29.4%), fMRI (1 patient, 0.6%), MEG (1 patient, 0.6%), SPECT (1 patient 0.6%), PET scan (53 patients, 33.1%), neuropsychology assessment (19 patients, 11.9%) and sodium amobarbital procedure WADA test (2 patients, 1.3%). In patients who experienced complications during EMU admission, six patients (12.0%) had prolonged LOS > 12 days. Patients with previous EMU admission were 32 (20.0%), including eleven patients (6.9%) were admitted for intracranial monitoring, but these patients had no statistically significant difference

Table 4A The correlation between length of stay (LOS) and EMU plan. This table illustrates the correlation between length of stay and EMU plan and found that patients concluded to have a resectvie surgical plan stayed for 7-9 days showed statistically significant results.

LOS (Days)	Surgical		Non-Surgical		Non-Conclusive			
	95 (59.4%)		23 (14.4%)		16 (10.1%)			
	Resective	Palliative	PNES	Non-Epileptic events	DAMA	No Seizures recorded	Hair Lice	Not Cooperative
1-3	1 (10.0)	2 (20.0)	1 (10)	0 (0)	0 (0)	0 (0)	1 (10)	1 (10)
4-6	9 (32.1)	5 (17.9)	4 (14.3)	0 (0)	1 (3.6)	2(7.1)	1 (3.6)	0 (0)
7-9	17 (41.5)*	2 (4.90)	8 (19.5)	1 (2.4)	0 (0)	3 (7.3)	1 (2.4)	0 (0)
10-12	14 (45.2)	5 (16.1)	4 (12.9)	2 (6.5)	1 (3.2)	2 (6.5)	0 (0)	0 (0)
Above 12	5 (10.0)	5 (10.0)	3 (6.0)	0 (0)	0 (0)	3 (6.0)	0 (0)	0 (0)
p-value	**0.003***		**0.309**		**0.07**			

*Statistically significant value (p<0.05). One-way ANOVA test was used to compare the variables.

LOS: Length of Stay; PNES: Psychogenic Non-epileptic Seizures; DAMA: Discharge Against Medical Advice.

Table 4B The correlation between days of EEG recording and EMU plan. This table illustrates the correlation between days of EEG recording and EMU plan and found that the non-conclusive plan (no-seizure recorded subgroup) was statistically significant for keeping patients for 6-10 days of EEG recording.

Days of EEG Recording	Surgical		Non-Surgical		Non-Conclusive			
	95 (59.4%)		23 (14.4%)		16 (10.1%)			
	Resective (76) 47.5	Palliative (19) 11.9	PNES (20) 12.5	Non-Epileptic events (3) 1.9	DAMA (2) 1.3	No Seizures recorded (10) 6.30	Hair Lice (3) 1.9	Not Cooperative (1) 0.6
0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (50.0)	1 (25.0)
1-5	32 (50.0)	9 (14.1)	4 (6.3)	1 (1.6)	1 (1.6)	4 (6.3)	0 (0)	0 (0)
6-10	37 (50.7)	7 (9.6)	13 (17.8)	2 (2.7)	1 (1.4)	**4 (5.5)***	1 (1.40)	0 (0)
11-15	5 (33.3)	2 (13.3)	3 (20.0)	0 (0)	0 (0)	1 (6.7)	0 (0)	0 (0)
16-20	2 (50.0)	1 (25.0)	0 (0)	0 (0)	0 (0)	1 (25.0)	0 (0)	0 (0)
p-value	**0.097**		**0.054**		**0.000***			

*Statistically significant value (p<0.05). One-way ANOVA test was used to compare the variables.

PNES: Psychogenic Non-epileptic Seizures; DAMA: Discharge Against Medical Advice.

with prolonged LOS. Of these patients, two had two previous admissions. Four patients were admitted for re-do surgery (2.5%), two patients stayed 7-9 days, and two for 10-12 days, without statistically significant difference. In comparing the LOS to the season of admission, 19 patients (38.0%) were admitted for >12 days during autumn, while in spring 17 patients (41.5%) stayed between 7-9 days.

Discussion

This study represents the first consecutive cases of EMU admissions to assess LOS and investigate specific patient characteristics and other factors that affect LOS in Saudi Arabia, to the best of our knowledge. At the EMU of King Faisal Specialist Hospital and Research Center (KFSHRC), almost 90% of admissions were diagnostic (surgical, non-surgical, or non-epileptic), with 11% being non-conclusive. These results align with previous reports that less than 15% of admissions were inconclusive, which is understandable due to the possible adverse outcomes and costs of misdiagnosis, such as unnecessary and non-therapeutic anti-seizure medications and admission to emergency units [1,7,12-14]. However, the prevalence of non-conclusive diagnoses at discharge ranged between 21% and 28% [15,16]. Furthermore, prolonging EEG for the accurate localization and lateralization of seizures is appropriate. When comparing patients with varying hospital stay durations, there were no significant differences in the frequency of non-conclusive admissions.

This study's finding suggests that having a surgical plan, especially resective surgery, the site of the focal seizure, and ADHD as comorbidity, are all significantly associated with a prolonged EMU length of stay. Several factors that were statistically significant predictors of more days of EEG recording, include diagnosis of focal seizure especially (ET), prolonged EMU length of stay, and first seizure timing. Length of stay was not significantly associated with patient age, the number of seizures, or the number of antiepileptic drugs (AEDs) at admission, which was concordant with a previous study assessing pre-admission clinical factors correlated with LOS in EMU [17]. Adverse events or complications were mostly found in prolonged LOS; however, there was no significant correlation between prolonged length of stay and the presence of EMU admission related complications. This result was in contrast with past literature suggesting that short LOS may have consequences beyond not establishing a diagnosis [14,18].

In our sample, patients with epileptic seizures had longer LOS compared to non-epileptic group. This result was in similar to previous reports [13]. The majority of monitoring types were those with scalp EEG who stayed longer than invasive monitoring. In contrast, Gazzola, DM, 2016, found that patients with invasive EEG recording had longer LOS. This result could be explained by the lesser number of invasive EEG recordings in our sample [6].

Patients who had a surgical decision as a discharge diagnosis had a prolonged stay >12 days. This finding is similar to previous reports; that patients admitted for the surgical plan experienced longer LOS than patients admitted for the only classification. This result might be due to the necessity to record several seizures or multifocal events for a pre-surgical evaluation. Furthermore, patients admitted for event classification had the shortest hospital stay concordant with the need sometimes recording only one clinical event for diagnosis [6,8,19,20]. Patients who had undergone resective surgery; had LOS of > 12 days more than patients who were admitted for palliative surgery. This finding is in line with the literature and was considered it reasonable for prolonged LOS for resective epilepsy surgery [13].

In our data, the second-longest admission period was in patients who waited for observation post resuming or adjusting AED, which aligned with other studies [6]. These studies supposed this result was due to minimizing the adverse effect or seizure occurrence after medication changes. In our study, patients who maintained on three AEDs kept on EEG recording for 6-10 days. This is observed in the literature that two days more than average LOS (aLOS) in patients on three or more AEDs [6]. This result could be explained by the longer time to taper the different AEDs. However, this is not applicable in all cases.

In our sample, intellectual disability (ID) in 39 patients, (24.4%) presented with comorbidities. In other reports, patients with ID account for 2% of all EMU admission [21].

The study sample included patients who experienced psychiatric manifestations such as depression, conversion, anxiety, and psychosis. These patients had extended hospital stays ranging from 5-15 days, with psychosis subgroups having the shortest stays in this group. Patients with psychiatric comorbidities had to stay longer by 0.9 days compared to other studies [6].

In terms of the admission season, we investigated the number of cases admitted per season and the corresponding LOS. We found that autumn had a higher number of patients and a longer LOS > 12 day for EMU admission followed by spring. Our aim was to measure the flow of patients to our unit and allocate resources equally to anticipate seasonal changes. In contrast to Hultman et al., winter and summer were the longer hospital LOS [22]. The LOS was longer in spring than fall, and there was no seasonal difference in LOS [23].

Our study has multiple strengths, including the variety of age groups, namely pediatric patients, as well as detailed demographics, medical history, spells/events history, and VEEG recording course and protocol, which have not been compared with the EMU final plan previously.

Our results may be limited by the inclusion of referred cases to our center, as we are the biggest referring center in the kingdom. Despite this, we could not generalize our results to build up the EMU pathway for all epilepsy centers in Saudi Arabia.

Conclusion

Patient who were admitted for pre-surgical evaluation had an average LOS longer than patients admitted for spell classification. In addition, patients with focal epilepsy styed longer than generalized or other events types. Our findings suggest that factors affecting the length of hospital stay or period of EEG recording during the admission should be taken into account

when planning EMU admissions to minimize the possible negative outcomes and complication. These results help build an EMU pathway that could shorten the length of stay with better assessment and plan.

Key Highlights

- Electroencephalography with video monitoring (VEEG) is a non-invasive diagnostic tool that is considered the gold standard for differentiating epileptic from non-epileptic events.
- Factors that contributed to prolonged length of stay (LOS) during EMU admission included technical, prolonged time to the first seizures, not recording the habitual seizures, presence of complications, observation after resuming AED, completion of phase I investigation, or a surgical procedure performed during the same admission.
- The average length of stay was 11.12 days and the mean for EEG recording days was 6.46 days.
- Patients with Attention Deficit Hyperactivity Disorder (ADHD) as comorbidity had prolonged length of EMU stay.
- More days of EEG recordings were required to diagnose focal in comparison to generalized epilepsy.
- Factors contributing to the length of hospital stay or period of EEG recording during the admission should be taken into account when planning EMU admissions to minimize the possible adverse outcomes and complications.

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