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Safety in the epilepsy monitoring unit: A retrospective study of 524 consecutive admissions

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ABSTRACT

The yield of monitoring patients at an epilepsy monitoring unit (EMU) depends on the recording of paroxysmal events in a timely fashion, however, increasing the risk of safety adverse events (AEs). We aimed to retrospectively study the frequency and risk factors for AE occurrences in all consecutive admissions to an adult EMU in a tertiary medical center. We also compared our findings with published data from other centers.

Between January 2011 and June 2014, there were 524 consecutive admissions to the adult EMU at the Tel Aviv Sourasky Medical Center. Adverse events were recorded in 47 (9.0%) admissions. The most common AE was 4-hour seizure cluster (58.7% of AEs) and, in decreasing frequency, AEs related to antiepileptic drugs (AEDs, 11.1%), falls and traumatic injuries (9.5%), intravenous line complications (9.5%), electrode-related (4.8%), status epilepticus (SE, 3.2%), and cardiac (1.6%) and psychiatric (1.6%) complications.

There were significantly more AEs among patients with a younger age at disease onset ($p = 0.005$), a history of temporal lobe epilepsy ($p = 0.046$), a history of focal seizures with altered consciousness ($p = 0.008$), a history of SE ($p = 0.022$), use of a vagal nerve stimulator ($p = 0.039$), and intellectual disability ($p = 0.016$) and when the indication for EMU monitoring was noninvasive or invasive presurgical evaluation ($p = 0.001$). Adverse events occurred more frequently when patients had more events in the EMU ($p = 0.001$) and among those administered carbamazepine ($p = 0.037$), levetiracetam ($p = 0.004$), clobazam ($p = 0.008$), and sulthiame ($p = 0.016$). Patients with a history of psychogenic nonepileptic seizures (PNESs) had significantly fewer AEs ($p = 0.013$).

Adverse events were not associated with the age, gender, duration of hospitalization or monitoring, AED withdrawal and renewal, seizure frequency by history, presence of major psychiatric comorbidities, abnormal neurological exam, or the presence of a lesion as on brain magnetic resonance imaging.

In conclusion, this study reveals that AEs are not unusual in the EMU and that seizure clustering is the most common among them. Adverse events occur more frequently in patients with more severe epilepsy and intellectual disability and in patients undergoing presurgical evaluations and less frequently in patients with PNESs.

1. Introduction

Epilepsy monitoring units (EMUs) use video-electroencephalography (video-EEG) recordings for several indications, such as distinguishing epileptic seizures from psychogenic nonepileptic seizures (PNESs) and other nonepileptic paroxysmal events, evaluating patients for epilepsy surgery, characterizing seizure types, and adjusting antiepileptic drug (AED) treatment. The yield of the monitoring is highly dependent on the recording of epileptic and/or nonepileptic events. To increase the likelihood of capturing events in a timely fashion, it is a standard practice to use activating procedures, such as AED withdrawal and sleep deprivation. These measures may provoke patients to experience an increase in the frequency and severity of seizures, therefore increasing the risks of injuries and medical complications.

Surveys of EMUs in the United States and Europe demonstrated that the most frequent safety adverse events (AEs) were falls, status epilepticus (SE), and postictal psychosis [1,2]. According to one study, major AEs appeared only during generalized tonic–clonic seizures (GTCSs), and the risk factors for AEs were epilepsy duration, existence of psychiatric comorbidity, and history of SE [1]. Seizure clusters (SCs) are other common AEs [2,3]. Studies on interventions to reduce the frequency of AEs highlight the importance of adherence to stricter safety measures [4], decreasing the number of missed seizures [5], using AED withdrawal protocols [6–8], and providing medical interventions in cases of SE or SC [2,6].

Whereas PNESs are frequently encountered in the EMU, in up to 32% patients in tertiary epilepsy centers [7], many studies on AEs in EMUs excluded those patients and included only patients with epilepsy

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[2,3,8,9]. In this study, we analyzed all consecutive admissions to an EMU in a tertiary center and examined the frequency and risk factors for the occurrences of AEs. We also compared our findings with published data from other centers.

2. Methods

2.1. Patients

This retrospective study included all consecutive patients older than 18 years who had been admitted to the EMU at the Tel Aviv Sourasky Medical Center (TASMC) between January 1, 2011 and June 30, 2014. This period was chosen because fully computerized and standardized medical files had become operable in the EMU. Prior to monitoring, all patients had signed informed consent forms that explained the purpose of monitoring, the possibility of AED withdrawal when required, and its potential risks, as well as the safety measures to ensure patient safety.

Medical files were reviewed and the following data documented: patient's age, gender, age of onset of epileptic or paroxysmal events, classification of paroxysmal syndrome (focal temporal epilepsy, focal extratemporal epilepsy, generalized epilepsy, PNES), seizure types according to ILAE classification [10], reported frequency of events prior to EMU admission, history of SE (Yes/No), presence of prediagnosed intellectual disability (Yes/No), presence of major psychiatric comorbidities (major mood disorder, schizophrenia, personality disorder, severe behavioral disturbances, history of suicide attempt, and substance abuse) (Yes/No), use of vagal nerve stimulation (VNS) (Yes/No), AED type, presence of abnormal neurological examination (Yes/No), and presence of a lesion on brain magnetic resonance imaging (MRI) (Yes/No). We also documented the indication for EMU admission, duration of hospitalization, duration of EEG monitoring, number of paroxysmal events during monitoring, first day of AED withdrawal and first day of AED renewal since admission, first day of paroxysmal events, number of AEs, and dates of occurrence and types of AEs as listed in Table 1.

An SC was defined as 3 focal seizures with impaired consciousness or 2 GTCSs occurring within 4 h [3]. Status epilepticus was defined as convulsive seizures lasting longer than 5 min or when consciousness was not regained between two consecutive seizures [11].

The study was approved by the local research ethics committee at TASMC.

2.2. Technical details and work routines at EMU

The EMU is located in physical proximity to the Department of Neurology. During the study period, it had 3 adult monitoring beds with a digital 32-/64-/128-channel video-EEG system (NicOne LTM system, Viasys, Madison, WI, USA). Surface EEG electrodes (Ag/AgCl) were placed according to the international 10–20 system, with additional inferior temporal or closely spaced electrodes when needed. Subdural strips and grids and depth electrodes (Ad-Tech Medical, Racine, WI, USA) were used for invasive EEG recordings. Two electrocardiography (ECG) electrodes were applied in all patients.

The EMU staff included 2 EEG technicians from 08:00 to 16:00 on weekdays (Sunday–Thursday) and one nurse who provided 24/7 coverage. A specialized epileptologist was in the EMU during the daytime and on call 24/7 (FF, SK, MN). There was full continuous access to the medical staff of the Department of Neurology. The patients were hospitalized in single rooms with private bathrooms and were monitored by the nurse via a monitoring screen located at the nurse's station. One companion received instructions from the EMU nurse and was encouraged to stay overnight in the patient's room. Thick padded side rails in the up position were used to minimize the risk of seizure-related injuries. In order to ensure intravenous (IV) access in case of emergency, IV catheters were placed in the antecubital fossa of patients who underwent AED withdrawal, as well as those with a high seizure frequency or who had been implanted with intracranial electrodes. Intravenous catheters were flushed twice daily with IV heparin 100 i.u.

Antiepileptic drug withdrawal followed the following outline: it was avoided during the first day of admission and, if required, started on the second day or later, taking into account the reported frequency of events prior to admission, the number and dosages of AEDs, and any history of SE. Starting from the second day of admission, the dose of a

Table 1
Characterization of safety adverse events (AEs) in the AED withdrawal and in the no-withdrawal groups.

AEs (in decreasing order of frequency)	Total number of AEs	AEs in withdrawal group	AEs in no-withdrawal group	AE characterization
Seizure clusters[a]	37	18	19	33 focal seizures with impaired consciousness 3 GTCSs 1 atypical absence
AED-related	7	2	5	3 VPA-induced hyperammonemia started in EMU 2 VPA-induced hyperammonemia taken prior to EMU admission 1 CBZ–LTG interaction 1 PB-induced increase in liver enzymes
Falls/traumatic injuries	6	4	2	2 atonic seizures 1 GTCS and nasal fracture outside the EMU 1 GTCS with eyebrow laceration 1 fall after PNES 1 fall and lip laceration due to extrapyramidal syndrome
IV line-related	6	4	2	3 phlebitis 2 *Staphylococcus aureus* bacteremia 1 extravasation of CT contrast agent
Electrode-related	3	1	2	1 extra-axial hematoma following subdural grid insertion 1 extra-axial swelling following subdural grid insertion 1 scalp discomfort due to scalp EEG electrodes leading to electrodes removal
Status epilepticus[b]	2	1	1	2 focal SE with impaired consciousness
Cardiac	1	0	1	1 ictal asystole
Psychiatric	1	1	0	1 nonlethal suicide attempt
Respiratory	0	0	0	
Thrombotic	0	0	0	
Resuscitation or death	0	0	0	
Total	63	31	32	

AED — antiepileptic drug, GTCS — generalized tonic–clonic seizure, PNES — psychogenic nonepileptic seizure, EMU — epilepsy monitoring unit, SE — status epilepticus, VPA — valproate, CBZ — carbamazepine, LTG — lamotrigine, PB — phenobarbital, CT — computerized tomography.

[a] Defined as 3 focal seizures with impaired consciousness or 2 GTCSs occurring within 4 h [3].

[b] Defined as convulsive seizures lasting longer than 5 min or when consciousness was not regained between two consecutive seizures [11].