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Adaptability of Pediatric Residents for the International League Against Epilepsy-2017 Seizure Classification with a Modular Education Program

Muharrem İmanli[1], Erdem Şimşek[2], Afshin Dezhakam[2], Seda Kanmaz[2], İpek Dokurel[2], Hepsen M. Serin[2], Sanem Yılmaz[2], Gül Aktan[2], Hasan Tekgül[2]

[1]Department of Pediatrics, Ege University Children's Hospital, İzmir, Turkey
[2]Division of Pediatric Neurology, Department of Pediatrics, Ege University Children's Hospital, İzmir, Turkey

What is already known on this topic?

- *International League Against Epilepsy (ILAE)-1981 and 1989 seizure classifications are not practically applicable even for neurologists and epileptologists. In 2017, ILAE proposed a new seizure classification aiming to facilitate seizure identification and improve communication among health professionals in outpatient setting.*

What this study adds on this topic?

- *After a single-day modular education program, participants achieved slightly higher success rates in the ILAE-2017 seizure compared to the ILAE-1981 classification.*

ABSTRACT

Objective: The aim of this study was to evaluate the adaptability of pediatric residents to the current seizure classification of the International League Against Epilepsy-2017 (ILAE-2017) using a modular education program (MEP).

Materials and Methods: The MEP design consisted of 8 modules, including 5 modules for the current version of the ILAE-2017 seizure classification and 3 modules for the older ILAE-1981 version. The MEP was implemented with a group of pediatric residents, and it comprised 50 illustrative pediatric seizure videos along with an instruction manual kit that included a seizure determinator. Following a 3-month follow-up period, a posttest was conducted using 58 new videos in the MEP.

Results: The overall success rates of the participants were similar both ILAE-2017 (41%) and ILAE-1981 (38.5%) seizure classifications in the post-MEP test. Regarding the ILAE-2017 modules, the participants demonstrated a higher proficiency in classifying focal nonmotor seizures (56.3%) compared to focal motor seizures (34.9%). However, when it came to generalized seizures, the participants had significantly lower accuracy rates for generalized nonmotor seizures (26%) compared to generalized motor seizures (46%) with the ILAE-2017 classification. The seizure types that were most commonly misclassified, with an error rate exceeding 50%, were automatisms and myoclonic seizures within the focal seizure modules and atypical absences in generalized seizure modules of ILAE-2017.

Conclusion: The single-day MEP yielded modest results, with a success rate of 41% in terms of the initial adaptability of pediatric residents to the ILAE-2017 seizure classification. However, to ensure successful implementation of the ILAE-2017 classification in clinical practice, additional booster applications of the MEP are required.

Keywords: Defining seizures, ILAE-2017 seizure classification, modular education program, residents in pediatrics, seizure semiology

INTRODUCTION

The initial step in the management of an epileptic child is the classification of the seizure. Residents in pediatrics often encounter childhood seizures and experience problems in defining seizures correctly. However, in daily practice, the International League Against Epilepsy (ILAE)-1981 and 1989 classifications are not very easy to apply.[1] ILAE proposed a new seizure classification in 2017 for health professionals as well as for patients and caregivers. This classification is based exclusively on ictal seizure semiology, either reported by the patient or observers or analyzed directly during video monitoring.[2]

Corresponding author:
Hasan Tekgül
✉ hasan.tekgul@ege.edu.tr
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The ILAE Commission released positional papers on the new classification, which included an instruction manual for the ILAE-2017 operational classification of seizure types.[2-4] The ILAE-2017 seizure classification has basic and expanded versions, depending on the desired degree of detail. The basic version is essentially the same as the expanded version but without subcategories. Seizures are first categorized by type of onset. Focal onset seizures are defined as "originating within networks limited to one hemisphere." While generalized seizures are defined as "originating at some point within, and rapidly engaging, bilaterally distributed networks."[2,3]

After the release of the new ILAE-2017 classification, there has been an apparent lack of studies in the current literature investigating how effectively health professionals, whose specialty is not necessarily neurology, classify seizures when dealing with epileptic children. There is a need for a common language in seizure classification among healthcare professionals, including residents, neurologists, epileptologists, electroencephalography (EEG) technicians, nurses, as well as patients and caregivers. Due to the COVID-19 pandemic, digital modular education programs (MEPs) and case-based seminars are suggested as a complete replacement for traditional practical courses in pediatrics.

The purpose of this study was to investigate the practicality of the ILAE-2017 seizure classification for the accurate recognition of seizure semiology by pediatric residents after undergoing a MEP followed by a post-MEP test evaluation.

MATERIALS AND METHODS

Participants

The study group consisted of 35 pediatric residents at Ege University Children's Hospital who had not received prior education on ILAE seizure classifications and voluntarily agreed to participate in the study.

Modular Education Program

MEP comprising 8 modules was developed for the 2 seizure classification systems of ILAE (1981 and 2017). The initial 5 modules were designed for ILAE-2017 classification: *module 1*: focal motor seizures, *module 2*: focal nonmotor seizures, *module 3*: generalized motor seizures, *module 4*: generalized nonmotor seizures, *module 5:* unknown onset and unclassified seizures. The remaining 3 modules were dedicated to the seizure types in ILAE-1981 classification; module *6 covered* partial seizures, *module 7* generalized seizures, and *module 8* unclassified seizures (Table 1).

Each module included concise explanatory information about the seizure types and presented video recordings of the relevant seizure types. Throughout the MEP, a total of 50 videos were shown, ensuring all seizure types are represented by one or more videos. The videos were obtained from video-EEG recordings and home videos. The videos were carefully reviewed and approved by the senior research team of pediatric neurologists (H.T., G.A, S.Y., and H.M.S.) and were organized according to ILAE-1981 and ILAE-2017 classifications.[3-6] Two members of the senior research team had prior experience in designing MEP modules for semiological seizure classification (SSC) in their previous paper.[7]

Post-Modular Education Program Test

The post-MEP test was conducted 3 months after the MEP. The test consisted of 58 videos, carefully selected by the same research to ensure that each video contained sufficient information for categorizing seizures according to both ILAE seizure classifications. Each seizure type was represented by one or more videos.

Table 1. Modular Education Program for ILAE-2017 and 1981 Seizure Classifications

ILAE-2017 Classification		**ILAE-1981 Classification**
Module 1: Focal motor seizures	**Module 3: Generalized motor seizures**	**Module 6: Partial seizures**
Automatisms	Tonic–clonic	Sensory
Atonic	Clonic	Motor
Clonic	Tonic	Sensory-motor
Epileptic spasms	Myoclonic	Psychic
Hyperkinetic	Myoclonic–tonic–clonic	Autonomic
Myoclonic	Myoclonic–atonic	Complex partial w/o aura
Tonic	Atonic	Complex partial w/o automatisms
Focal to bilateral tonic–clonic	Epileptic spasms	Secondarily generalized
Module 2: Focal nonmotor seizures	**Module 4: Generalized nonmotor seizures**	**Module 7: Generalized seizures**
Autonomic	Typical absence	Absence
Behavioral arrest	Atypical absence	Tonic–clonic
Cognitive	Myoclonic absence	Atonic
Emotional	Absence with eyelid myoclonia	Myoclonic
Sensory		Other
		Unclassified
	Module 5: Unknown onset/ unclassified seizures	**Module 8: Unclassified* seizures**
	Tonic–clonic	
	Epileptic spasms	
	Behavioral arrest	
	Unclassified	

ILAE, International League Against Epilepsy.
*Seizures that cannot be classified either because of inadequate data or has no corresponding category in the 1981 classification.

Table 2. The Overall Success Rates of MEP for ILAE-1981 and ILAE-2027 Seizure Cassifications

Seizure Classification		ILAE-1981			
		Correct	Not Correct	Did Not Classify	Total
ILAE-2017	Correct	450 (54%)	370	13	833 /2000 (41.7%) *
	Not correct	310	844	13	1167
	Did not classify	0	0	30	30
	Total	760 /1974 (38.5%)*	1214	56	2030

ILAE, International League Against Epilepsy; MEP, modular education program.
*P = .04.

The study was implemented in 2 steps:

1. *Application of the MEP:* Residents were informed about the learning objectives, and the MEP was administered in 3 consecutive 1-hour sessions separated by 15-minute coffee breaks. The MEP included all types of seizures encompassed by the ILAE-1981 and ILAE-2017 classifications. Additionally, the participants received the Turkish version of the instruction manual kit from the ILAE Commission, which included the seizure determinator and a glossary of terms for the 2 ILAE classifications.
2. *Post-MEP test:* The participants were shown 58 videos comprising 18 focal motor seizures, 12 focal nonmotor seizures, 16 generalized motor seizures, 8 generalized nonmotor seizures, and 4 unknown onset or unclassified seizures. Each video was played 2 times, and an additional 60 seconds were provided for seizure classification. At the end of each video, the participants were asked to classify the seizure according to both ILAE classifications. They were instructed to provide a written answer they deemed most appropriate and not to leave any questions unanswered.

Statistical Analysis

The questionnaire form and the participants' answers to all the seizure videos in the posttest of MEP were evaluated. The unanswered questions were not included in the evaluation because some participants had to take a break from the test due to their duties related to patient care. Data analysis was performed in Ege University Faculty of Medicine Department of Biostatistics. SPSS (Statistical Package for the Social Sciences) for Windows 25.0 package program (IBM Corp.; Armonk, NY, USA) was used for statistical analysis. The relationship between categorical variables was examined by McNemar chi-square test. All hypothesis controls were performed at 0.05 significance level.

This article is produced from thesis work conducted at Ege University in 2017 by Dr. M.İ. The purpose of the study was explained and written informed voluntary consent was received from every participant and the parents or legal guardians of the children whose video recordings were used. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

RESULTS

Overall Success Rates of the Modular Education Program

All 35 participants took the posttest which consisted of 58 seizure videos after 3 months of MEP application. The participants watched the videos and classified the seizures according to both ILAE-1981 and 2017 classifications. A total of 2030 questions were asked for each classification. Only 56 questions (2.7%) were left unanswered by participants; 56 for ILAE-1981 and 30 for ILAE-2017.

The participants demonstrated higher success rates using the ILAE-2017 (41.6%) compared to the ILAE-1981 classification (38.5%) (P = .04). The classification was correct in both ILAE classifications for 54.0% of the answers. The correct answer rates for modules in ILAE-2017 and 1981 classifications are presented in Table 2.

The Success Rates of the Modular Education Program Modules for International League Against Epilepsy-1981 Classification

Among the total of 2030 questions for the ILAE-1981 classification, the participants answered 1974 (97.2%) and left 56 (2.8%) questions unanswered. The participants provided 760 correct answers out of the total 1974 (38.5%). The success rate for module 6 which covered partial seizures was 34.3% (259 correct answers out of 755). 49.39% (403/816) for generalized seizures (module 7) and 24.32% (98/403) for unclassified seizures (module 8). The success rate for generalized seizures was significantly higher compared to partial and unclassified seizures (P < .001, P < .001). Also, the success rate for partial seizures was significantly higher than for unclassified seizures (P < .001).

The Success Rates of the Modular Education Program Modules for International League Against Epilepsy-2017 Classification

Out of the 2030 questions for ILAE-2017 classification, the participants answered 2000 (98.5%) questions, and 30 (1.5%) questions were left unanswered. The participants classified the seizure correctly 833 times out of 2000 (41.65%). The success rate for focal motor seizures (module 1) was 34.88% (218 correct answers out of 625). For focal nonmotor seizures (module 2), the success rate was 56.28% (233/414); for generalized motor seizures (module 3), it was 45.9% (252/549); for generalized nonmotor seizures (module 4), it was 25.09% (69/275), and for unknown onset and unclassified seizures (module 5), it was 44.53% (61/137). The success rate for module 2 was significantly higher than that for module 1 (P < .001). Also, the success rate for module 3 was significantly higher than for module 4 (P < .001). When evaluated in pooled groups, the success rate for focal onset seizures (modules 1 and 2) was 43.41% (451 correct answers out of 1039). 38.96% (321/824) for generalized seizures (modules 3 and 4) and 44.53% (61/137) for unknown onset and unclassified seizures (module 5). The difference between the groups was not significant (P = .122). The correct answer rates

Table 3. The Success Rates for Seizure Types in ILAE-2017 Seizure Classification

ILAE-2017 Seizure Classification			
Seizure Type	**Correct Rate (%)**	**Seizure Type**	**Correct Rate (%)**
Module 1 *218 CA/625 TA* Focal motor seizures	34.88	Module 3 *252 CA/549 TA* Generalized motor seizure	45.9
Automatisms	45.1	Tonic–clonic	61.4
Atonic	94.3	Clonic	51.4
Clonic	36.4	Tonic	40
Epileptic spasms	25.7	Myoclonic	17.1
Hyperkinetic	9.5	Myoclonic–tonic–clonic	48.6
Myoclonic	2.8	Myoclonic–atonic	28.6
Tonic	48.6	Atonic	62.3
Focal to bilateral tonic–clonic	47.1	Epileptic spasms	27.6
Module 2 *233 CA/414 TA* Focal nonmotor seizures	56.28	Module 4 *69 CA/275 TA* Generalized nonmotor seizures	25.09
Autonomic	88.6	Typical absence	29.3
Behavioral arrest	44.8	Atypical absence	2.9
Cognitive	71.4	Myoclonic absence	0
Emotional	25.7	Absence with eyelid myoclonia	74.3
Sensory	54.2		
		Module 5 *61 CA/137 TA* Unknown onset/ unclassified seizures	44.53
		Tonic–clonic	68.6
		Epileptic spasms	57.1
		Behavioral arrest	28.6
		Unclassified	20

CA, correct answer; ILAE, International League Against Epilepsy; TA, total answer(*) module 1 vs. module 2, (□) module 3 vs. module 4, (□) module 1+2 vs. module 3+4 ($P < .001$).

for seizure subtypes in the ILAE-2017 classification are presented in Table 3.

The Seizure Mismatch in International League Against Epilepsy-2017 Classification

The mismatch rates varied widely (37-86%) in the ILAE-2017 classification. The most confused seizure type was automatic seizures (86%), with emotional seizures in the ILAE-2017 classification. Additionally, atypical absences were confused with typical absences, and focal myoclonic seizures were confused with focal clonic seizures in 60% of the answers in the ILAE-2017 classification. The most frequently mismatched seizure types in the ILAE-2017 classification are presented in Table 4.

Table 4. The Most Mismatched Seizure Types in ILAE-2017 Classification

Seizure Type	Confused With	Wrong Answer Rate
Automatisms	Emotional	(n = 30; 86%)
Atypical absence	Typical absence	(n = 21; %60%)
Focal myoclonic	Generalized myoclonic	(n = 21; 60%)
Focal to bilateral tonic–clonic	Focal tonic	(n = 20; 57%)
Emotional	Cognitive	(n = 16; 46%)
Focal clonic	Focal myoclonic	(n = 15; 43%)
Generalized tonic	Focal tonic	(n = 14; 40%)
Typical absence	Behavior arrest	(n = 13; 37%)

ILAE, International League Against Epilepsy.

DISCUSSION

Identification of seizure semiology is of great importance for seizure classification. The seizure classifications of ILAE-1981 and the semiological seizure classification (SSC) are generally criticized for being complicated and impractical in an outpatient setting.[1,2,8] These classifications have not been widely utilized in daily pediatric neurology practice or in general pediatrics.[9] In June 2017, ILAE proposed a new seizure classification that aimed to be easier to implement for all health professionals as well as for nonprofessionals. In this study, we assessed the adaptability of the ILAE-2017 seizure classification in pediatric residents through a 1-day MEP. The presented study introduced an easily applicable MEP version of the ILAE-2017 seizure classification to a population of pediatric residents yielding modest results. The correct response rate in the ILAE-1981 seizure classification was 38.5%, whereas it was 41.7% for the ILAE-2017 seizure classification. We also evaluated the most confused seizure types in the new classification.

Previous studies have compared various seizure classification systems in different aspects.[7-12] Baykan et al[2] conducted a study with 28 neurologists with an interest in epileptology and reported a diagnostic accuracy of 81.4% for ILAE-1981 classification and 87.5% for SSC. In a study by Parra et al[10] 3 epileptologists classified seizure videos, and interobserver agreement rates were reported to be 38.6% for ILAE-1981 classification and 63.3% for SSC. However, these studies did not utilize an MEP program for health professionals. In the present study, we implemented an MEP for the participants. After 3 months of MEP, the posttest revealed a modest yield was obtained for ILAE-2017 classification (41.7%) compared to the ILAE-1981 classification (38.5%). There is only 1 clinical study conducted by Isler et al[7] that utilized an MEP for SSC in 50 healthcare professionals, which reported a success rate of 4%-46% in pretest and 42-98% in posttest for different seizure types.[7] Our MEP provided a considerable correct answer rate for each module of the MEP; the correct rates of modules 1-5 were module 1 (focal motor seizures, 34.5%), module 2 (focal nonmotor seizures, 56.28%), module 3 (generalized motor seizures, 45.9%), module 4 (generalized nonmotor seizures, 25.09%), and module 5 (unknown onset , 44.53%). It is important to mention that while Isler et al[7] evaluated the MEP yield on the same day of its application, our study conducted the posttest after 3 months, potentially diminishing the effect of the MEP over time.

Isler et al[7] reported that the majority of the participants (96%) correctly defined atonic seizure in the posttest. Similarly, in our study, the most successfully identified seizure type was atonic seizure in both classifications. When compared to the correct response rates among the groups in the ILAE-2017 seizure classification, participants were better able to identify focal onset nonmotor seizures compared to motor seizures. However, for generalized seizures, motor seizures were classified more accurately than nonmotor seizures. Typical and atypical absence seizures are very difficult to distinguish for

non-neurologists. This may have contributed to the lower success rate in the generalized nonmotor seizure group. When compared to the correct response rates for partial, generalized, and unclassified seizure groups; generalized seizures were classified more accurately (49.39%).

In ILAE-1981 classification, partial seizures are thought to be more difficult to classify due to their more complex subgroup classification, which includes simple and complex partial seizures. This complexity arises from the difficulty of distinguishing them solely based on semiological properties. However, the ILAE-2017 Seizure Classification aims to address these challenges by providing a classification system that is more reflective of clinical practice and facilitates easier description of seizures, thereby improving communication among clinicians and patients.[2] Although the correct response rate was higher for the ILAE-2017 classification, this study suggests that both ILAE-1981 and ILAE-2017 classifications may pose challenges in daily practice for non-neurologists. Nonetheless, this study along with the MEP contributed to the creation of a common language among pediatric residents.

We also evaluated the mismatched seizure types in the ILAE classification, revealing a range of seizure mismatch rates ranging from 37% to 86%. The seizure types most commonly confused were as follows: automatic seizures in module 1 (86%), absences in module 4 (60%), myoclonic seizures in modules 1 and 2 (60%), and tonic–clonic seizures in module 2 (57%). According to Noachtar and Peters,[13] Holmes et al[14] used SSC to identify 926 dialeptic seizures in 54 patients with generalized epilepsy and found that automatisms were more common in typical absences, while loss of muscle tone was more evident in atypical absences. Atypical absences are characterized by a slow onset and/or termination, significant tonus changes, and spike wave discharges slower than 3Hz in the EEG.[3] In our study, 60% of the participants confused atypical absence seizures with typical absence seizures. In the study conducted by Isler et al,[7] 10% of the participants confused epileptic spasms with myoclonic seizures. In our study, 29% (n = 10) of the participants misidentified epileptic spasms with myoclonic seizure types in the ILAE-2017 seizure classification. An epileptic spasm is a type of seizure that results in a brief tonic component after a myoclonic jerk,[13] which explains the expected confusion with myoclonic seizures due to their similar semiology.[3] Isler et al[7] reported hypermotor, atonic, and gelastic seizures as the most accurately identified seizure types, whereas simple motor seizures reported to be the least accurately identified seizure types. Furthermore, Parra et al[10] reported that hypermotor or automotor seizures exhibited the highest interobserver agreement rates in the SSC, while the absence seizures had the best interobserver agreement rate in ILAE-2017 classification.

This study has several limitations that need to be addressed. Firstly, a pre-MEP test was not conducted to assess the participants' baseline knowledge. Incorporating such a test would have provided a more accurate evaluation of knowledge gain. However, it is crucial to note that the primary objective of this study was not to assess the effectiveness of the presented MEP. Instead, our focus was to evaluate the ease of adaptability of non-neurologist healthcare professionals to the ILAE-2017 seizure classification, which aims to improve communication about seizures among a wider population. Another limitation is the absence of a booster education program during the study. Implementing such a program would likely have resulted in higher success rates for both classifications, better reflecting real-world clinical practice, and further enhancing participants' understanding and utilization of the seizure classifications.

Additionally, this study did not provide detailed data or discussion on participant characteristics, including factors such as success rate variability and its statistical associations. Parameters such as the entrance score of the residency program, year of residency, previous rotations (including child neurology), and whether participants had received child neurology training within 3 months after the MEP were not thoroughly explored.

Despite these limitations, our study contributes to the understanding of the challenges and potential benefits of implementing the ILAE-2017 seizure classification among non-neurologist healthcare professionals, specifically pediatric residents. It highlights the areas of the classification that pose difficulties, such as differentiating between seizure types with similar semiology or distinguishing between motor and nonmotor manifestations in generalized seizures. These findings can guide future educational interventions and training programs to improve the accuracy and practical applicability of seizure classification among healthcare professionals.

To address the impact of the timing of the posttest assessment, our study conducted the assessment 3 months after the MEP. This interval was chosen to allow for a sufficient duration for knowledge retention and potential integration of the classification system into participants' daily practice. However, the timing of the assessment may have influenced the results. Over the course of 3 months, participants might have encountered various clinical scenarios and challenges that could have affected their retention and application of the ILAE-2017 seizure classification. Some participants may have had limited exposure to patients with specific seizure types during this period, leading to decreased accuracy in classifying those types. Additionally, participants' engagement in other rotations and training activities during the 3-month period may have influenced their focus and ability to retain the knowledge gained from the MEP.

Future studies could explore the impact of different posttest assessment timings on the results to determine the optimal time interval for evaluating the long-term effectiveness of training programs. Additionally, assessing the participants' knowledge and skills at multiple time points after the MEP could provide insights into the retention and practical application of the seizure classification over an extended period.

CONCLUSION

The study findings indicate that our single-day MEP resulted in a moderate success rate regarding the practical adaptability of pediatric residents to the ILAE-2017 seizure classification. However, it is crucial to acknowledge that while the statistical analysis produced significant results, the clinical significance and practical impact of the achieved outcomes with the new classification were only marginally significant. Therefore, this

study does not strongly support the notion that the ILAE-2017 classification significantly improves adaptability. The implementation of booster education programs and consideration of effective educational approaches are crucial for enhancing adaptability to both classifications. These findings contribute to the ongoing efforts to enhance the communication and understanding of seizure semiology among healthcare professionals in pediatric neurology practice.

Ethics Committee Approval: All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Informed Consent: The purpose of the study was explained and written informed voluntary consent was received from every participant and the parents or legal guardians of the children whose video recordings were used.

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