

RESEARCH ARTICLE

Duration of epileptic seizure types: A data-driven approach

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Abstract

Objective: To determine the duration of epileptic seizure types in patients who did not undergo withdrawal of antiseizure medication.

Methods: From a large, structured database of 11 919 consecutive, routine video-electroencephalography (EEG) recordings, labeled using the SCORE (Standardized Computer-Based Organized Reporting of EEG) system, we extracted and analyzed 2742 seizures. For each seizure type we determined median duration and range after removal of outliers (2.5–97.5 percentile). We used surface electromyography (EMG) for accurate measurement of short motor seizures.

Results: Myoclonic seizures last <150 ms, epileptic spasms 0.4–2 s, tonic seizures 1.5–36 s, atonic seizures 0.1–12.5 s, when measured using surface EMG. Generalized clonic seizures last 1–24 s. Typical absence seizures are rarely longer than 30 s (2.75–26.5 s) and atypical absences last 2–100 s. In our patients, the duration of focal aware (median: 27 s; 1.25–166 s) and impaired awareness seizures (median: 42.5 s; 9.5–271 s) was shorter than reported previously in patients undergoing withdrawal of antiseizure medication. All focal seizures terminated within 10 min. Median duration of generalized tonic–clonic seizures was 79.5 s (57–102 s) and of focal-to-bilateral tonic–clonic seizures was 103.5 (77.5–237 s). All tonic–clonic seizures terminated within 5 min.

Significance: This comprehensive list of seizure durations provides important information for characterizing seizures and diagnosing patients with epilepsy. The upper limits of seizure durations are helpful in early recognition of imminent status epilepticus.

KEYWORDS

database, duration limits, EEG, SCORE

Members of the European Reference Network EpiCare: Danish Epilepsy Centre and Aarhus University Hospital.

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1 | INTRODUCTION

Duration of various epileptic seizure types is important information, with high clinical relevance. It contributes to defining and diagnosing seizure types.^{1–5} Knowing the upper limit of seizure duration of the seizure types is important for early identification of patients who are at risk for status epilepticus.⁶

Epileptic seizures encompass a broad spectrum of electroclinical phenomena. Correct classification is needed for choosing the optimal treatment and advising patients regarding prognosis.^{7–9} When the electroclinical picture matches a known epilepsy syndrome, the prospects for targeted treatment, prognostic counseling, as well as selection of patient populations for research improve considerably.^{1,9–12} Knowing how long a seizure lasts is an essential part of seizure characterization.

Moreover, knowing when a seizure is expected to stop spontaneously helps recognize prolonged seizures and define the time limit for impending status epilepticus (SE), so that preventive emergency treatment can be started in a timely manner.^{6,13} As Dobesberger et al.¹³ also highlighted, the limitation in previous studies was that seizure duration was determined from patients admitted to the video-EEG (electroencephalography) monitoring unit and antiseizure medication withdrawal. Only a few studies have looked at the effect of antiseizure medication withdrawal on seizure duration.^{13–15} Negative correlation between antiseizure medication serum levels and seizure duration reported in two studies^{13,14} indicates that antiseizure medication withdrawal possibly prolongs seizure duration. This correlation is further supported by studies showing low antiseizure medication serum levels in patients with SE.^{16,17}

In current definitions, the duration of many seizure types has largely been based on expert opinion. Only a few studies have systematically measured duration of the seizure types.^{13,14} Comparing results from studies reporting the duration of different seizure types is challenging due to the heterogeneity of study populations (adults vs children, refractory epilepsy vs new-onset seizures, antiseizure medication withdrawal vs well-treated patients, different seizure types, and different terminology). Furthermore, the methods used to measure seizure duration have been variable, based either on ictal EEG or clinical duration (or both), recorded with either scalp EEG or intracranial electrodes.

Using a large, structured video-EEG database (Standardized Computer-Based Organized Reporting of EEG [SCORE]), we systematically measured the duration of various types of seizures from consecutive patients who had undergone routine EEG recordings, and did not undergo antiseizure medication withdrawal, thus reflecting the habitual state of the patients. Using a data-driven approach, we provide here duration limits for the various

Key points

- We measured duration of seizure types during routine video-EEG (electroencephalography), in patients who did not undergo withdrawal of antiseizure medication.
- For each seizure type we provide median duration and range after removal of outliers.
- Measured by surface electromyography (EMG), myoclonic jerks last <150 ms, epileptic spasms 0.4–2 s, tonic seizures 1.5–36 s, and atonic seizures 0.1–12.5 s.
- Typical absences are rarely >30 s (range: 2.75–26.5) and atypical absences last 2–100 s.
- Most focal seizures terminate within 9 min and generalized tonic-clonic seizures terminate within 5 min.

seizure types in a comprehensive manner. Our results offer a useful tool for seizure characterization and help identify impending SE.

2 | METHODS

Video-EEG was recorded as a part of routine diagnostic workup of patients at the Danish Epilepsy Centre, Dianalund, Denmark, and in a satellite EEG laboratory in Nuuk, Greenland. EEG was recorded with the NicoletOne EEG system (Natus Neuro, USA), using the extended scalp EEG electrode array of the International Federation of Clinical Neurophysiology (IFCN).¹⁸ Recordings were carried out by certified, experienced EEG technicians, for 30 min (routine EEG), 60 min (sleep EEG), or up to 4 h (short-term video-EEG monitoring), including provocations such as intermittent photic stimulation (IPS) and hyperventilation during a routine or ambulatory recording in the awake state. Surface electromyography (EMG) electrodes were added when motor phenomena were expected, based on referral information. Two to six channels of bipolar surface EMG were used. The most common placement was bilaterally on sternocleidomastoid, splenius capitis, deltoid, biceps brachii, quadriceps femoris, and tibialis anterior muscles.¹⁸ However, other muscles were included when different semiology was indicated in the referral.

EEG and semiology features were prospectively registered in the database, using the SCORE system^{19,20} (Holberg EEG, Norway). All scored features were automatically stored in a Microsoft Structured Query Language (SQL) database. For this study, we identified all routine,

sleep, and ambulatory video-EEG studies with clinical episodes in patients who did not undergo antiseizure medication withdrawal. We extracted the scored features using SQL scripts.

Each recording was evaluated by two experienced, board-certified clinical neurophysiologists. One of the authors (PML) reassessed all recordings with clinical episodes. When discordance regarding classification or duration of the clinical episode occurred, it was resolved by a consensus discussion involving a third expert (SB). For this study, we evaluated the following features: demographics, seizure type, and diagnosis.

Seizure duration was measured as EEG duration, clinical duration, and cumulative seizure duration. Clinical seizure duration was defined as the time between initial clinical sign(s)—either objective or reported by the patient (whichever came first)—and cessation of the clinical phenomena. EEG seizure duration was defined as the time between the initial transition from background activity to ictal activity (focal or generalized) and the cessation of that activity/initiation of postictal EEG activity (suppression or slowing). The cumulative seizure duration was defined as the duration of both EEG activity and ictal clinical signs seen together as it is often evaluated in clinical praxis: from the first ictal sign (clinical or electrographic, whichever came first) to the last ictal phenomena (clinical or electrographic, whichever came last). For myoclonic seizures in patients with surface EMG, we used this modality for an objective measurement, due to the short duration of this seizure type. For each seizure type we calculated mean duration, range (minimum-maximum), and duration after removal of outliers (2.5th–97.5th percentile). Seizures were classified in accordance with International League Against Epilepsy (ILAE) terminology.⁷ In addition, we evaluated the duration of psychogenic nonepileptic seizures (PNES). We grouped seizures by type and determined the range of cumulative seizure durations for each seizure type. For each patient, median seizure durations were determined per seizure type, and then used for subsequent analyses. We excluded recordings where measurement of seizure duration was not possible, as explained below. In patients with progressive myoclonic epilepsy, the confluent runs of seizures made duration measurement impossible ($n = 5$). Status epilepticus occurred in 20 patients. For technical reasons, some seizures were only partly recorded on video or EEG ($n = 16$). The video had been accidentally deleted in 54 recordings.

3 | RESULTS

The SCORE video-EEG database comprised 11 919 consecutive recordings from 7833 patients (50% female),

recorded between April 30 2013 and September 7 2020. The median age for the whole database population was 24 years (range 1 day to 92 years); 1.2% ($n = 146$) of the recordings were done on patients younger than 1 year of age (median 8 months, range 1 day to 11 months). In total, 2742 seizures from 887 video-EEG recordings (725 patients) were analyzed in this study. The median age was 17 years (range: 3 weeks to 79 years; 60% female).

Table 1 describes the patient population for each seizure type. For rare seizure types, the number of patients is lower, whereas for seizures commonly occurring during EEG recordings in patients not undergoing withdrawal of antiseizure medication, such as absences and focal seizures, the number of patients is higher (Table 1).

Table 2 and Figure 1 summarize the durations of the seizure types. Generalized motor seizures had durations of less than 1 min, with the exception of (primary) generalized tonic-clonic seizures, with an upper duration of 102 s. When measured using surface EMG signals, the duration of generalized myoclonic seizures was between 30 and 140 ms (after excluding outliers). Most typical absence seizures had durations less than 27 s (with outliers up to 32 s), whereas atypical absence seizures had durations up to 100 s. Most focal impaired awareness seizures stopped within 5 min (outliers up to almost 10 min), whereas focal aware seizures stopped within 3 min. The focal-to-bilateral tonic-clonic seizures in our series of patients not undergoing antiseizure medication withdrawal, stopped spontaneously within 4 min. PNES had durations exceeding 30 min, with a median of 3.5 min (Table 2).

4 | DISCUSSION

Using a large, structured database of seizures in patients not undergoing withdrawal of antiseizure medication, we determined the duration of various seizure types, to help characterize seizures and to establish the upper limit of seizures likely to stop without external intervention. To our knowledge, no other study has comprehensively evaluated the typical duration of different seizure types.

4.1 | Myoclonic seizures

Dobesberger et al.¹³ report median clinical duration for myoclonic seizures to be 3 s (range 1–5 s). They do not mention whether they used EMG electrodes to measure muscle contractions but we suspect that the remarkably longer duration in their study could be due to the fact that they measured repetitive myoclonic jerks. Alternatively, the overevaluation of the duration could be due to assessing video only (i.e. without EMG electrodes). Our

TABLE 1 Patient population for each seizure type

Seizure types	Number of patients (in parentheses: percentage of females)	Median age in years (range)	Number of recordings (number of seizures)
Generalized Myoclonic	149 (51%)	15 (0.5–72)	178 (648)
With EMG	96 (47%)	16 (0.5–72)	122 (499)
Without EMG	35 (71%)	17 (0.83–66)	36 (86)
Repetitive (EMG)	11 (36%)	11 (3–64)	13 (38)
Myoclonic-tonic	4 (25%)	6 (1–11)	4 (8)
Myoclonic-atonic	3 (33%)	6 (1–11)	3 (17)
Focal myoclonic	9 (78%)	18 (0.42–26)	9 (31)
Generalized clonic	4 (25%)	16 (4–30)	4 (13)
Generalized spasms	53 (42%)	4 (0.75–55)	64 (174)
Focal spasms	5 (40%)	18 (3–64)	6 (21)
Generalized tonic	61 (54%)	23 (0.83–67)	69 (170)
Tonic spasms	24 (46%)	11 (1–48)	24 (47)
Focal tonic	21 (52%)	21 (4–57)	25 (70)
Atonic	8 (62%)	3 (1–30)	9 (37)
Generalized tonic-clonic	8 (75%)	26 (11–46)	8 (8)
Focal-to-bilateral Tonic-clonic	8 (50%)	30 (0.5–72)	8 (8)
Typical absence	115 (64%)	12 (4–46)	148 (445)
Absence with eyelid myoclonia	7 (100%)	14 (4–17)	7 (27)
Atypical absence	36 (56%)	9 (2–53)	38 (132)
Myoclonic absence	7 (43%)	7 (4–15)	7 (26)
Eyelid myoclonia	35 (91%)	14 (6–62)	51 (201)
Focal impaired Awareness	52 (48%)	25 (2–75)	53 (84)
Focal aware	15 (60%)	25 (3–67)	16 (33)
Focal awareness Unknown	46 (41%)	17 (0.07–74)	48 (88)
Unknown (subtle)	22 (50%)	13 (1–57)	23 (78)
Electrographic	28 (50%)	24 (4–74)	29 (55)
PNES	172 (74%)	34 (10–79)	179 (341)

study results for single myoclonic seizures are similar to those of several, previous studies.^{21–24} Many of those studies suggest that myoclonic jerks of longer duration (>100ms) are of subcortical or spinal origin.^{21,22,24} The study by Wang et al.²⁵ reports a duration of <400ms for myoclonic seizures (based on EMG measurements), which is a much higher upper limit. The ILAE defines myoclonic seizures with an upper duration of 100ms.^{26,27} Our data suggest updating this to <150ms.

4.2 | Epileptic spasms

We found that the duration of epileptic spasms was between 0.4 and 2 s (outliers: 0.3–2.5 s). Several previous studies reported a duration of epileptic spasms between 0.2 and 2 s, which is close to our findings.^{28–30} The seizure

duration of epileptic spasms defined in the ILAE position paper for epileptic syndromes is 1–3 s,² and the ILAE glossary states 0.5–2 s.^{26,27} As no reference is given, we assume it was based on expert opinion. Our results are very close to this, but in rare cases spasms can be outside the range specified in the ILAE glossary.

4.3 | Tonic seizures

The ILAE glossary gives an imprecise definition of tonic seizure duration: “a few seconds to minutes.”^{26,27} In addition, the ILAE position paper on epilepsy syndromes in infants and neonates states that tonic seizures last longer than epileptic spasms, which last up to 3s.² Other papers mention tonic seizure durations of over 3s to a couple of minutes.^{13,14,25,30} Excluding the outliers, we

TABLE 2 Seizure duration (seconds) for each seizure type

Seizure types	Seizure duration								
	EEG			Clinical/EMG					
	Median	Range	2.5–97.5 percentile	Median	Range	2.5–97.5 percentile			
			Median	Range	2.5–97.5 percentile	Median	Range	2.5–97.5 percentile	
Generalized Myoclonic									
Single (EMG)	–	–	–	0.08	0.025–0.17	0.03–0.14	–	–	–
Repetitive (EMG)	–	–	–	0.5	0.2–3	0.2–3	–	–	–
Myoclonic-tonic	3.75	2–16	2–16	4.5	1.5–16	1.5–16	4.5	2–16	2–16
Myoclonic-atonic	1.25	0.7–1.5	0.7–1.5	1.25	0.7–1.5	0.7–1.5	1.25	0.7–1.5	0.7–1.5
Focal Myoclonic (EMG)	–	–	–	0.1	0.08–0.13	0.08–0.13	–	–	–
Generalized clonic	4.25	1–24	1–24	4	1–19.5	1–19.5	4.25	1–24	1–24
Generalized spasms	1	0.3–2.5	0.4–2.1	1	0.3–2	0.4–2	1	0.3–2.1	0.4–2
Focal spasms	1.15	0.4–1.25	0.4–1.25	0.8	0.47–1.2	0.47–1.2	0.9	0.47–1.2	0.47–1.2
Generalized tonic	8	2.5–60	3–50.5	7.5	1.5–47	1.5–36	8.5	2.5–50	3–36
Tonic spasms	6	2.1–21	2.1–21	6	2.1–21	2.1–21	6	2.1–21	2.1–21
Focal Tonic	15	2–62	2–62	13	1.5–148	1.5–148	16.5	2–148	2–148
Atonic	1	0.5–13	0.5–13	0.7	0.09–12	0.09–12	1	0.5–14	0.5–14
Generalized Tonic–Clonic	79.5	57–102	57–102	74.5	54–102	54–102	79.5	57–102	57–102
Focal-to-bilateral Tonic–clonic	103	77.5–237	77.5–237	90.5	77–216	77–216	103.5	77–237	77–237
Typical absence	7.25	1.75–32	2.75–26	5	1.25–28	1.25–23	7.25	2.25–32	2.75–26
Atypical absence	14.75	2–100	2–100	12	0.5–52	0.5–52	15	2–100	2–100
Myoclonic absence	7.5	3–12	3–12	7	2.5–11	2.5–11	7.5	3–12	3–12
Absence with eyelid myoclonia	4.5	4–8	4–8	2.5	2–6	2–6	5	4–8	4–8
Eyelid Myoclonia	1.5	0.5–8	0.5–8	1.5	0.5–7	0.5–7	1.5	0.5–8	0.5–8
Focal impaired awareness	42	5.5–558	9.5–263	37	4–484	8–253	42.5	5.5–560	9.5–271
Focal aware	24	1.5–166	1.5–166	15	1.5–125	1.5–125	27	1.25–166	1.25–166
Focal awareness unknown	21	3–151	3–149	15	0.8–126	0.8–126	22	1–151	3–149
Unknown (subtle)	7	0.5–920	0.5–920	4	0.5–920	0.5–920	7.5	0.5–920	0.5–920
Electrographic	20	10–100	10–100	–	–	–	–	–	–
PNES	–	–	–	205	0.5–3600	0.7–2024	–	–	–

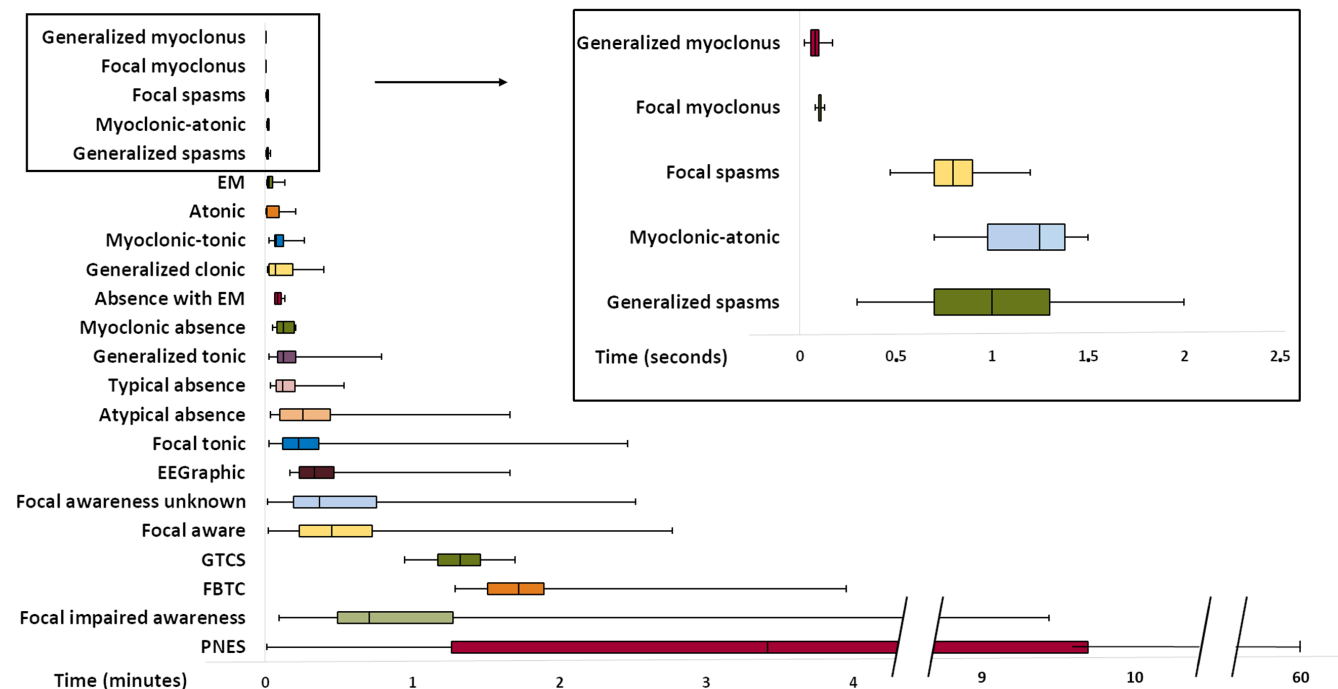


FIGURE 1 Duration of seizure types. This infographic gives an overview on seizure durations: 25–75 percentile values, median and range (outliers). EM, eyelid myoclonia; FBTC, focal to bilateral tonic-clonic seizures; GTCS, generalized tonic-clonic seizures; PNES, psychogenic nonepileptic seizure.

measured generalized tonic seizure duration (cumulative) between 3–36 s (range: 2.5–50.5 s). Defining the duration of tonic seizures between 3 s and 1 min seems reasonable.

4.4 | Atonic seizures

Seventy percent (26 seizures in six recordings) of atonic seizures were generalized, 13.5% (five seizures in one recording) consisted of negative myoclonus, 13.5% (five seizures in one recording) were atonic-myoclonic, and 3% (one seizure) were atonic-clonic-tonic. Table 2 describes seizure duration measurements for generalized atonic seizures. The cumulative median duration was 1 s (range 0.5–14 s). The range of seizure duration for generalized atonic seizures seen in our study was broader than that stated in previous studies.^{28,30} The ILAE position paper on epilepsy syndromes in childhood describes atonic seizures lasting from one to a few seconds in patients with Lennox-Gastaut syndrome.³

4.5 | Generalized and focal to bilateral tonic-clonic seizures

Our findings for generalized tonic-clonic seizures are similar to those reported by Nordli et al.³¹ Dobesberger et al.¹³ reported median seizure durations for both generalized and focal to bilateral tonic-clonic seizures

similar to ours but with a broader range with longer seizures than seen in our study. This could be explained by a difference in the patient population, namely long-term monitoring (LTM) patients with refractory epilepsy undergoing antiseizure medication withdrawal, supporting the suggestion that antiseizure medication withdrawal prolongs seizure duration. Jenssen et al.¹⁴ also found median durations (both for generalized and focal to bilateral tonic-clonic seizures) similar to our findings, but their results on the other hand showed a shorter range of seizure duration as did Kauffman et al.³² for focal to bilateral tonic-clonic seizures. Using intracranial electrodes, Hartl et al.¹⁵ and Kim et al.³³ found median seizure duration for focal to bilateral tonic-clonic seizures that are similar to our results. Our results show that bilateral tonic-clonic seizures last between 1 and 4 min, which coincides with the T1 time point at 5 min suggested by Trinkka et al.⁶ for tonic-clonic SE. An important limitation of our study design is that generalized tonic-clonic seizure rarely occur in short EEG recordings in patients who did undergo withdrawal of antiseizure medication. In our study only 16 such seizures occurred.

4.6 | Typical absences

The median duration values for typical absence seizures seen in our study are comparable with those of Sadleir

et al.,³⁴ Kessler et al.,³⁵ Panayiotopoulos,³⁶ Holmes et al.,³⁷ and Yagi et al.³⁸ Furthermore, the recent ILAE position paper on Idiopathic Generalized Epilepsy (IGE) syndromes⁵ specifies median seizure durations close to our study results and states that typical absences are rarely >30s, which is in agreement with our results.

Our results indicate that the T1 time point for absence SE proposed by Trinka et al.⁶ at 10–15 min may be too long, since typical absence seizures spontaneously terminate within 30s. A shorter T1 time point, for example, 1 min, could be considered for typical absence seizures.

4.7 | Atypical absences

The prevalent comment on the duration of atypical absences in literature is that they last longer than typical absences.^{37,38} However, Holmes et al. report atypical absence lasting 8–13s.³⁷ Yagi et al.³⁸ found that about half of the atypical absences recorded stopped within 10s and 10% lasted 30s or more. Similarly, our study showed that 46% of atypical absences stopped within 10s (67% within 20s), and only 19% lasted 30s or more (4.7% 40s or more). It is important to emphasize that only a subset of atypical absence seizures last longer than typical absences. We did not record any atypical absence seizure longer than 100s, suggesting that a T1 time point of 2 min should be reasonable.

4.8 | Myoclonic absences

Zanzmera et al.³⁹ as well as Yang et al.⁴⁰ found a much longer seizure duration than what we found in our study. The ILAE position paper on epileptic syndromes in childhood³ states that myoclonic absences last 10–60s. They refer to Zanzmeras study, which found a maximum duration of 35.5 s. A study by Myers and Scheffer⁴¹ report myoclonic absences that last 10–60s, although they specifically describe myoclonic absences with complex gestural automatisms. The maximum seizure duration in our series was 18s for myoclonic absence, which is shorter than the durations suggested by the aforementioned articles.

4.9 | Absence with eyelid myoclonia

Absences with eyelid myoclonia were seen only in female patients in our study, with a median age in puberty (14years), similar to the previously described patient profiles.^{42,43} Most studies do not distinguish between

eyelid myoclonia without absences and absences with eyelid myoclonia and describe this seizure type as eyelid myoclonia with or without absences, lasting 1–4s. Giannakodimos and Panayiotopoulos found a mean duration of 3.2 s (range 1.5–6.0 s) for eyelid myoclonia with or without absences, with only one seizure over 6s, concluding that when eyelid myoclonia were associated with impairment of consciousness they lasted longer than 2s.⁴³ These findings are similar to our results.

4.10 | Eyelid myoclonia

The ILAE position paper on epileptic syndromes reports that eyelid myoclonia typically last less than 1 to 3s and always less than 6s,³ based on expert opinion.⁴⁴ We recorded eyelid myoclonia without absence, longer than 6s (range 0.5–8 s). However, all seizures over 6.5 s occurred during photic stimulation.

4.11 | Focal seizures

The median duration of focal aware (27s) and focal impaired awareness seizures (42.5 s) was remarkably shorter compared to previous reports (42–62s and 64–78s, respectively).^{13,33,45} This could be explained by their study populations undergoing antiseizure medication withdrawal^{13,14,33} and/or using intracranial recordings.^{33,45} Dobesberger et al.¹³ described a cumulative clinical seizure duration (99%) being 7 min in focal impaired awareness seizures and 11 min in focal aware seizures. We found an opposite trend, with focal aware seizures lasting less than those with impaired awareness. Kauffmann et al.³² and Seethaler et al.⁴⁶ also report that most focal seizures terminate within 2–3 min. Although most focal seizures terminate within 4 min, we recorded seizures lasting up to 9 min (median for a single patient), indicating that the T1 time point proposed by Trinka et al.⁶ for focal impaired awareness SE set at 10 min is appropriate.

4.12 | Electroencephalographic seizures

Our study results on EEG duration for electroencephalographic seizures are shorter than what has been reported in previous studies,^{13,33,46–48} which could be due to those studies using intracranial recordings, and the patients having refractory epilepsy and undergoing antiseizure medication withdrawal due to epilepsy surgery workup.

4.13 | PNES

The median clinical seizure duration of PNES was close to 3 min, which is in accordance with the results of Senevittrane et al.⁴⁹ In addition, Anis et al.⁵⁰ found that only 5.4% of PNES last less than 2 min.

5 | CONCLUSION

We provide data on seizure duration measured during routine video-EEG recordings in patients who did not undergo withdrawal of antiseizure medication. These figures help define the seizure types and set the T1 time point for early recognition of imminent SE. By using surface EMG, we were able to measure accurately the duration of short, generalized motor seizures (myocloni, spasms, atonic seizures). These results provide useful information for clinical decision-making.

AUTHOR CONTRIBUTIONS

Pirgit Meritam Larsen: Conceptualization, Formal Analysis, Original Draft Preparation, Review & Editing. Stephan Wüstenhagen: Formal Analysis, Review & Editing. Daniella Terney: Formal Analysis, Review & Editing. Elena Gardella: Formal Analysis, Review & Editing. Harald Aurlien: Formal Analysis, Review & Editing. Sándor Beniczky: Conceptualization, Formal Analysis, Methodology, Resources, Project Administration, Original Draft Presentation, Review & Editing.

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CONFLICT OF INTEREST

Harald Aurlien is CMO and shareholder of Holberg-EEG. The remaining authors do not have conflicts of interest related to this work.



DATA AVAILABILITY STATEMENT

Investigators may request access to anonymized individual data including seizure duration sorted by seizure types, 24 months after the trial is complete. Prior to use of the data, proposals need to be approved by the data safety officer at the Danish Epilepsy Centre, and a signed data sharing agreement will then be approved. All documents are for a predetermined time of 12 months.

APPROVAL

This retrospective, noninterventional study, using an anonymized database does not require institutional review board approval, according to the Danish legislation. The institutional data safety officer has approved the study.

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REFERENCES

- Wirrell E, Tinuper P, Perucca E, Moshé SL. Introduction to the epilepsy syndrome papers. *Epilepsia*. 2022;63(6):1330–2. <https://doi.org/10.1111/epi.17262>
- Zuberi SM, Wirrell E, Yozawitz E, Wilmshurst JM, Specchio N, Riney K, et al. ILAE classification and definition of epilepsy syndromes with onset in neonates and infants: position statement by the ILAE task force on nosology and definitions. *Epilepsia*. 2022;63(6):1349–97. <https://doi.org/10.1111/epi.17239>
- Specchio N, Wirrell EC, Scheffer IE, Nabbout R, Riney K, Samia P, et al. International league against epilepsy classification and definition of epilepsy syndromes with onset in childhood: position paper by the ILAE task force on nosology and definitions. *Epilepsia*. 2022;63(6):1398–442. <https://doi.org/10.1111/epi.17241>
- Riney K, Bogacz A, Somerville E, Hirsch E, Nabbout R, Scheffer IE, et al. International league against epilepsy classification and definition of epilepsy syndromes with onset at a variable age: position statement by the ILAE task force on nosology and definitions. *Epilepsia*. 2022;63(6):1443–74. <https://doi.org/10.1111/epi.17240>
- Hirsch E, French J, Scheffer IE, Bogacz A, Alsaadi T, Sperling MR, et al. ILAE definition of the idiopathic generalized epilepsy syndromes: position statement by the ILAE task force on nosology and definitions. *Epilepsia*. 2022;63(6):1475–99. <https://doi.org/10.1111/epi.17236>
- Trinka E, Cock H, Hesdorffer D, Rossetti AO, Scheffer IE, Shinnar S, et al. A definition and classification of status epilepticus—report of the ILAE task force on classification of status epilepticus. *Epilepsia*. 2015;56(10):1515–23. <https://doi.org/10.1111/epi.13121>
- Fisher RS, Cross JH, French JA, Higurashi N, Hirsch E, Jansen FE, et al. Operational classification of seizure types by the international league against epilepsy: position paper of the ILAE Commission for Classification and Terminology. *Epilepsia*. 2017;58(4):522–30. <https://doi.org/10.1111/epi.13670>
- Beghi E. The concept of the epilepsy syndrome: how useful is it in clinical practice? *Epilepsia*. 2009;50(Suppl. 5):4–10. <https://doi.org/10.1111/j.1528-1167.2009.02112.x>
- Berg AT, Berkovic SF, Brodie MJ, Buchhalter J, Cross JH, van Emde BW, et al. Revised terminology and concepts for organization of seizures and epilepsies: report of the ILAE commission on classification and terminology, 2005–2009. *Epilepsia*. 2010;51(4):676–85. <https://doi.org/10.1111/j.1528-1167.2010.02522.x>

10. Beghi E, Giussani G, Sander JW. The natural history and prognosis of epilepsy. *Epileptic Disord.* 2015;17(3):243–53. <https://doi.org/10.1684/epd.2015.0751>
11. Scheffer IE, Berkovic S, Capovilla G, Connolly MB, French J, Guilhoto L, et al. ILAE classification of the epilepsies: position paper of the ILAE Commission for Classification and Terminology. *Epilepsia.* 2017;58(4):512–21. <https://doi.org/10.1111/epi.13709>
12. Wirrell EC, Nabbout R, Scheffer IE, Alsaadi T, Bogacz A, French JA, et al. Methodology for classification and definition of epilepsy syndromes with list of syndromes: report of the ILAE task force on nosology and definitions. *Epilepsia.* 2022;63(6):1333–48. <https://doi.org/10.1111/epi.17237>
13. Dobesberger J, Ristić AJ, Walser G, Kuchukhidze G, Unterberger I, Höfler J, et al. Duration of focal complex, secondarily generalized tonic-clonic, and primarily generalized tonic-clonic seizures—a video-EEG analysis. *Epilepsy Behav.* 2015;49:111–7. <https://doi.org/10.1016/j.yebeh.2015.03.023>
14. Jenssen S, Gracely EJ, Sperling MR. How long do most seizures last? A systematic comparison of seizures recorded in the epilepsy monitoring unit. *Epilepsia.* 2006;47(9):1499–503. <https://doi.org/10.1111/j.1528-1167.2006.00622.x>
15. Hartl E, Seethaler M, Lauseker M, Rémi J, Vollmar C, Noachtar S. Impact of withdrawal of antiepileptic medication on the duration of focal onset seizures. *Seizure.* 2019;67:40–4. <https://doi.org/10.1016/j.seizure.2019.03.005>
16. DeLorenzo RJ, Hauser WA, Towne AR, Boggs JG, Pellock JM, Penberthy L, et al. A prospective, population-based epidemiologic study of status epilepticus in Richmond, Virginia. *Neurology.* 1996;46(4):1029–35. <https://doi.org/10.1212/wnl.46.4.1029>
17. Knake S, Rosenow F, Vescovi M, Oertel WH, Mueller HH, Wirbatz A, et al. Incidence of status epilepticus in adults in Germany: a prospective, population-based study. *Epilepsia.* 2001;42(6):714–8. <https://doi.org/10.1046/j.1528-1157.2001.01101.x>
18. Seeck M, Koessler L, Bast T, Leijten F, Michel C, Baumgartner C, et al. The standardized EEG electrode array of the IFCN. *Clin Neurophysiol.* 2017;128(10):2070–7. <https://doi.org/10.1016/j.clinph.2017.06.254>
19. Beniczky S, Aurlien H, Brøgger JC, Fuglsang-Frederiksen A, Martins-da-Silva A, Trinka E, et al. Standardized computer-based organized reporting of EEG: SCORE. *Epilepsia.* 2013;54(6):1112–24. <https://doi.org/10.1111/epi.12135>
20. Beniczky S, Aurlien H, Brøgger JC, Hirsch LJ, Schomer DL, Trinka E, et al. Standardized computer-based organized reporting of EEG: SCORE - second version. *Clin Neurophysiol.* 2017;128(11):2334–46. <https://doi.org/10.1016/j.clinph.2017.07.418>
21. Oguni H, Hayashi K, Imai K, Funatsuka M, Sakauchi M, Shirakawa S, et al. Idiopathic myoclonic-astatic epilepsy of early childhood—nosology based on electrophysiologic and long-term follow-up study of patients. *Adv Neurol.* 2005;95:157–74.
22. Wang B, Cai FC. Polyneuro-electrophysiological studies of myoclonus in children. *Zhonghua Er Ke Za Zhi.* 2009;47(10):750–6. Chinese. PMID: 20021809.
23. Shibasaki H, Hallett M. Electrophysiological studies of myoclonus. *Muscle Nerve.* 2005;31(2):157–74. <https://doi.org/10.1002/mus.20234>
24. Zutt R, Elting JW, van Zijl JC, van der Hoeven JH, Roosendaal CM, Gelauff JM, et al. Electrophysiologic testing aids diagnosis and subtyping of myoclonus. *Neurology.* 2018;90(8):e647–57. <https://doi.org/10.1212/WNL.0000000000004996>
25. Wang B, Cai FC. Clinical and polyneuroelectrophysiological characteristics of infantile spasm. *Zhonghua Er Ke Za Zhi.* 2007;45(2):109–14.
26. Beniczky S, Tatum WO, Blumenfeld H, Stefan H, Mani J, Maillard L, et al. Seizure semiology: ILAE glossary of terms and their significance. *Epileptic Disord.* 2022;24(3):447–95. English. <https://doi.org/10.1684/epd.2022.1430>
27. Blume WT, Lüders HO, Mizrahi E, Tassinari C, van Emde BW, Engel J Jr. Glossary of descriptive terminology for ictal semiology: report of the ILAE task force on classification and terminology. *Epilepsia.* 2001;42(9):1212–8. <https://doi.org/10.1046/j.1528-1157.2001.22001.x>
28. Mothersill IW, Hilfiker P, Krämer G. Twenty years of ictal EEG-EMG. *Epilepsia.* 2000;41(Suppl 3):S19–23. <https://doi.org/10.1111/j.1528-1157.2000.tb01530.x>
29. Kellaway P, Hrachovy RA, Frost JD Jr, Zion T. Precise characterization and quantification of infantile spasms. *Ann Neurol.* 1979;6(3):214–8. <https://doi.org/10.1002/ana.410060306>
30. Chen Y, Yu Q, Yang WD, Xiao CX, Yang EJ, Guo HA, et al. Application of VEEG+SEMG in diagnosing different motor seizure types. *Zhonghua Yi Xue Za Zhi.* 2013;93(29):2283–7. Chinese.
31. Nordli D, Riviello J, Niedermeyer E. Seizures and epilepsy in infants to adolescents. In: Schomer D, da Silva F, editors. *Niedermeyer's Electroencephalography.* 6th ed. Philadelphia: Wolters Kluwer; 2011. p. 479–540.
32. Kaufmann E, Seethaler M, Lauseker M, Fan M, Vollmar C, Noachtar S, et al. Who seizes longest? Impact of clinical and demographic factors. *Epilepsia.* 2020;61(7):1376–85. <https://doi.org/10.1111/epi.16577>
33. Kim D, Cho JW, Lee J, Joo EY, Hong SC, Hong SB, et al. Seizure duration determined by subdural electrode recordings in adult patients with intractable focal epilepsy. *J Epilepsy Res.* 2011;1(2):57–64. <https://doi.org/10.14581/jer.11011>
34. Sadleir LG, Farrell K, Smith S, Connolly MB, Scheffer IE. Electroclinical features of absence seizures in childhood absence epilepsy. *Neurology.* 2006;67(3):413–8. <https://doi.org/10.1212/01.wnl.0000228257.60184.82>
35. Kessler SK, Shinnar S, Cnaan A, Dlugos D, Conry J, Hirtz DG, et al. Pretreatment seizure semiology in childhood absence epilepsy. *Neurology.* 2017;89(7):673–9. <https://doi.org/10.1212/WNL.0000000000004226>
36. Panayiotopoulos CP. Treatment of typical absence seizures and related epileptic syndromes. *Paediatr Drugs.* 2001;3(5):379–403. <https://doi.org/10.2165/00128072-200103050-00006>
37. Holmes GL, McKeever M, Adamson M. Absence seizures in children: clinical and electroencephalographic features. *Ann Neurol.* 1987;21(3):268–73. <https://doi.org/10.1002/ana.410210308>
38. Yagi K, Morikawa T, Miyakoshi M, Kakegawa N, Osawa T, Seino M, et al. Analytic study of epileptic absence seizures and effect of sodium valproate treatment. *Monogr Neural Sci.* 1980;5:137–41. <https://doi.org/10.1159/000387496>
39. Zanzmera P, Menon RN, Karkare K, Soni H, Jagtap S, Radhakrishnan A. Epilepsy with myoclonic absences: Electroclinical characteristics in a distinctive pediatric epilepsy phenotype. *Epilepsy Behav.* 2016;64(Pt A):242–7. <https://doi.org/10.1016/j.yebeh.2016.08.023>

40. Yang ZX, Liu XY, Qin J, Zhang YH, Wu Y, Jiang YW. Clinical and electroencephalographic characteristics of epilepsy with myoclonic absences. *Zhonghua Er Ke Za Zhi*. 2009;47(11):862–6. Chinese.
41. Myers KA, Scheffer IE. Myoclonic absence seizures with complex gestural automatisms. *Eur J Paediatr Neurol*. 2018;22(3):532–5. <https://doi.org/10.1016/j.ejpn.2017.12.003>
42. Zawar I, Knight EP. Epilepsy with eyelid Myoclonia (Jeavons syndrome). *Pediatr Neurol*. 2021;121:75–80. <https://doi.org/10.1016/j.pediatrneurol.2020.11.018>
43. Giannakodimos S, Panayiotopoulos CP. Eyelid myoclonia with absences in adults: a clinical and video-EEG study. *Epilepsia*. 1996;37(1):36–44. <https://doi.org/10.1111/j.1528-1157.1996.tb00509.x>
44. Striano S, Capovilla G, Sofia V, Romeo A, Rubboli G, Striano P, et al. Eyelid myoclonia with absences (Jeavons syndrome): a well-defined idiopathic generalized epilepsy syndrome or a spectrum of photosensitive conditions? *Epilepsia*. 2009;50(Suppl. 5):15–9. <https://doi.org/10.1111/j.1528-1167.2009.02114.x>
45. Afra P, Jouny CC, Bergey GK. Duration of complex partial seizures: an intracranial EEG study. *Epilepsia*. 2008;49(4):677–84. <https://doi.org/10.1111/j.1528-1167.2007.01420.x>
46. Seethaler M, Lauseker M, Ernst K, Rémi J, Vollmar C, Noachtar S, et al. Hemispheric differences in the duration of focal onset seizures. *Acta Neurol Scand*. 2021;143(3):248–55. <https://doi.org/10.1111/ane.13356>
47. Gosavi TD, See SJ, Lim SH. Ictal and interictal EEG patterns in patients with nonconvulsive and subtle convulsive status epilepticus. *Epilepsy Behav*. 2015;49:263–7. <https://doi.org/10.1016/j.yebeh.2015.05.011>
48. Zangaladze A, Nei M, Liporace JD, Sperling MR. Characteristics and clinical significance of subclinical seizures. *Epilepsia*. 2008;49(12):2016–21. <https://doi.org/10.1111/j.1528-1167.2008.01672.x>
49. Seneviratne U, Minato E, Paul E. How reliable is ictal duration to differentiate psychogenic nonepileptic seizures from epileptic seizures? *Epilepsy Behav*. 2017;66:127–31. <https://doi.org/10.1016/j.yebeh.2016.10.024>
50. Anis S, Fahoum F, Korczyn AD, Sverdlov D, Abramovici S, Mina Y, et al. Atypical duration of epileptic and psychogenic nonepileptic events. *Epilepsy Behav*. 2020;111:107145. <https://doi.org/10.1016/j.yebeh.2020.107145>

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