Master thesis

Diagnosis of first paroxysmal events at the children's ER at a Swedish Regional hospital – including a one year follow up

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Populärvetenskaplig sammanfattning

Bakgrund.

Barn som söker på akuten efter att de för första gången upplevt ett anfall innebär en diagnostisk utmaning för doktorn då det finns många tänkbara diagnoser däribland, ett epileptiskt krampanfall, ett feberkrampsanfall, ett provocerat anfall eller svimning. I många vetenskapliga artiklar framhålls vikten av ett noggrannt anamnes-upptagande när det kommer till att diagnosticera anfall. Information om barnets hälsotillstånd och utvecklingsnivå, förekomsten av provocerande faktorer, en noggrann beskrivning av anfallet tillsammans med en neurologisk undersökning är ofta viktiga för att komma fram till en korrekt diagnos. Vad det gäller diagnostiska undersökningar förespråkas återhållsamhet med EEG (undersökning av hjärnans spontana elektriska aktivitet) i de lokalt författade riktlinjerna, medan återhållsamhet med avbildande undersökningar förespråkas såväl lokalt som internationellt.

Mål

Målet med den här studien var att ta reda på hur man kom fram till en diagnos av anfall på barnakuten i Lund 2010, och att under ett år följa upp de barn som haft anfall.

Material och metoder

Vi sökte med hjälp av ett speciellt journalsöksystem upp journalerna tillhörande de 161 barn som varit på barnakuten i Lund 2010 på grund av ett första anfall och samlade in bakgrundinformation om barnet, beskrivning av anfallet och handläggningsgång.

Resultat

Av de 161 barn som sökte sig till barnakuten på grund av ett första anfall fick fem en epilepsidiagnos, 31 diagnosticerades med ospecificerade anfall, åtta med annat, 59 med feberkramp, tre med provocerade anfall och 55 med synkope.

Vi upptäckte att det ofta saknas mycket information i journalerna som hade kunnat klargöra omständigheterna kring anfallet. Dessutom antecknar man ofta inte huruvida man genomfört en neurologisk undersökning och hur den i så fall utföll. Däremot gör man fler EEG än vad de lokala riktlinjerna förespråkar.

Inom det år då vi följde barnen återkom 54 med anledning av anfallet eller på grund av nya anfall. De slutgiltiga diagnoserna var: 17 fall av epilepsi, 10 fall av ospecificerade anfall, fem fall av annat, 17 fall av feberkramp, ett fall av provocerade anfall och fyra fall av synkope.

Slutsats

En slutsats man kan dra av detta är att doktorer som arbetar på akuten skulle kunna behöva någon sorts minnesstöd för att påminna sig om viktiga punkter i anamnesupptagandet och den kliniska undersökningen.

Abstract

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Background

First epileptic seizures can be difficult to diagnose properly as there are many differential diagnoses including provoked seizures, febrile seizures, syncope, breath holding spells and psychogenic seizures. Many articles highlight the importance of a diligent medical history taking, focusing on child characteristics, precipitating factors and event semiology to differ between diagnoses, while imaging studies, and locally also EEG, are considered to have less central roles.

Aim

We aimed to benchmark current practices at the children's ER in Lund in diagnosing paroxysmal events and also to follow the management and eventual revisions of diagnosis during one year from index event.

Methods

Charts of children who have sought care 2010, visits specified by International Classification of disease ICD codes compatible with paroxysmal events were reviewed and those who were seen at the ER because of their first paroxysmal event were included in our cohort.

Results

161 children were seen at ER for their first paroxysmal event at the children's ER in Lund 2010. The initial diagnoses were: epilepsy (n=5), unspecified seizures (n=31), other (n=8), febrile seizures (n=59), provoked seizures (n=3), and syncope (n=55).

We found that there was a considerable amount of potentially important information not documented in the medical charts. Also neurological examinations were often not, or insufficiently, recorded. On the other hand, EEGs were performed in situations not indicated by the local pro memoriam.

Roughly one third of children were seen again (n=54). The final diagnoses were epilepsy (n=17), unspecified seizures (n=10), other (n=5), febrile seizures (n=17), provoked seizures (n=1), and syncope (n=4).

Conclusions

We found that important information is often lacking in medical charts, that clinical neurological examination is often insufficiently recorded, while generally more investigations than recommended were performed. This implies the need of a bedside aid for doctors to guide and remind them of important aspects of history-taking and clinical examination.

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Introduction

The child presenting to the emergency ward with a first seizure constitutes a differential diagnostic problem [1-3]. Has the child experienced a seizure of epileptic nature defined as a "transient occurrence of signs and/or symptoms due to abnormal excessive or synchronous neuronal activity in the brain" [4]? Or did the event have a different etiology altogether? One must also consider whether the seizure was provoked or unprovoked, as this has important implications for both immediate management and long term prognosis.

Epilepsy, defined as more than one unprovoked seizure, has an incidence that ranges between 50-80/100000 in childhood in developed countries [5, 6]. The incidence of single unprovoked seizures is substantially higher [6, 7]. Febrile seizures, defined as a seizure occurring at temperature higher than 38ºC, without central nervous system (CNS) infection among children 6-60 months old, is the most common seizure disease in childhood with two to five percent of children suffering at least one. Simple febrile seizures, less than 15 minutes duration and generalized from onset, have an excellent prognosis [8],why it is not necessary to return to the ER in case of a recurrence. Apart from fever, seizures can be provoked by metabolic disruptions, intoxication, trauma, central nervous system infection, hypertension and intracranial space occupying lesions or hemorrhages. The provoking factor should be in close connection in time with the seizure event, eg meningitis at the age of two is not considered a provoking factor for seizures occurring at the age of four. Depending on etiology, syncope can be both benign as in the case of neurally mediated vasovagal syncope or dangerous, as for example long QT-syndrome.

The importance of medical history taking in assigning a correct diagnosis to a paroxysmal event is underlined in several articles. [2, 9-11]. However, there is scant evidence published of what constitutes a well done medical history taking for pediatric paroxysmal events. Successful attempts to formulate evidence based criteria to distinguish between syncope and seizures have been published for the adult population [12]. No corresponding initiative has been undertaken on the pediatric side. Proformas and seizure description forms have been developed for children as well as adults in emergency room (ER) and first fitter clinic settings, but the basis of these have been cumulated clinical knowledge rather than evidence based methods. Features stressed as important in history-taking regarding a paroxysmal event include; associated factors including health and developmental status of the child and family history of epilepsy, possible precipitating factors, ictal phenomena including aura, duration, pattern of motor activity, breathing pattern, cyanosis or pallor, consciousness or responsiveness, tongue bite, continence, postictal

events including fatigue, confusion, amnesia, and transient focal weakness (13-16). Several guidelines on how to manage a first seizure are available. Some of these are evidence based but unspecific as to whether they concern adults or children[9]. Other evidence based articles are concerned with children but not focusing on diagnostic issues [13, 14]. Others still are based on cumulated clinical knowledge to offer guidance to those less experienced [15, 16]. Consequences of misdiagnosing paroxysmal events can be somber eg psychogenic episodes treated with antiepileptic drugs with possible side effects and toxicity as well as not receiving proper care for the disorder at hand[17].

According to a local pro memoriam (PM), investigations including EEG should not be undertaken at a first seizure unless the child has a close relative with a diagnosis of epilepsy, there is a suspicion that the seizure is secondary to known brain damage or there is an abnormal neurological exam[18]. There is wide agreement that imaging studies should not be performed routinely in the diagnostic work-up of either febrile, afebrile first seizures or newly presenting epilepsy [8, 19, 20]. If imaging is indicated magnetic resonance imaging is the preferred modality.

With this background stressing the pivotal role of history taking and the secondary importance of investigations in determining a diagnosis of paroxysmal events in mind, we aimed to benchmark current practice in the children's ER of a Swedish regional hospital during 2010, with the hope of being able to suggest improvements;

We aimed to explore how a diagnosis of paroxysmal events is arrived at, with a special focus on history taking, and will therefore review the medical charts of all patients presenting to the hospital following a paroxysmal event. Moreover, we aimed to investigate the subsequent development and management of the paroxysmal event in a retrospective one year follow-up of the children's charts

Material and Methods

Index event recognition

There were 13558 doctor visits at the children's ER in Lund year 2010. All cases registered at the ER because of a first paroxysmal event were included in the study. These paroxysmal events were defined as visits coded with International Classification of Disease (ICD) codes; P28.4 – other apnoea of the newborn, R25.2 - cramp and spasm, R56.0 - febrile convulsions, R55.(9) - syncope and collapse, R56.8 - other and unspecified seizures, R56.8A breath-holding spell with pallid or cyanotic syncope, G40.0-9 - epilepsy and G41.0-41.9 - status epilepticus. The diagnosis code R56.8A is a code which is local and not internationally accepted. Using the hospital specific search instrument "Finn" we sifted through charts from the entire children's hospital, so as not to miss out on children who had experienced a paroxysmal event but had been assigned an ICD code at the ER that we did not explicitly search for. We also

performed partial searches on ER charts only using another search instrument "Qlickview" to assess the completeness of the search. There was one child not identified with "Finn" but with "Qlickview" and two children only identified using "Finn". All three were added to our cohort. We thus identified 462 children (Figure 1). By reading the computerized medical chart (MELIOR) we determined whether the child met our inclusion criteria: that the event was the first paroxysmal event brought to attention at a secondary care center e.g. hospital and for those charts selected that were not ER charts whether the child had passed through the ER. If this was the case the child was included in our cohort. Of the 234 cases identified at the ER 79 children did not meet the inclusion criteria, two children were excluded because they were diagnosed with epilepsy although they had not had an EEG nor did the clinical findings suggest epilepsy, and one child was excluded because the charts were unobtainable. 152 children remained. Of the 228 children identified at different wards and outpatient clinics, 219 did not meet the inclusion criteria. Our final cohort thus consisted of 161 children.

Index event variables

Thereafter we constructed a database, using IBM SPSS Statistics 20, with information from the medical charts of the index event. This included information extracted from the charts from the ER as well as charts from the ward if the child was admitted.

We included information on;

Child characteristics - age at event in months to the nearest integer, sex, prior disease and development, information on pregnancy and early life, heredity for epilepsy or febrile convulsions.

Event semiology - whether witnessed by person accompanying the child to the ER, length in minutes categorized to ≤ 2min, 2≥ 10min, ≥10min, provoking factors, premonitory experiences, consciousness, generalized motor activity, lateralized motor activity, colour, tounge bite, whether eyes were open, incontinence, fever at time of arrival to ER, occurrence during sleep, clustered seizures, postictality.

Management at the ER and if applicable during ambulance transport –

Date and time of the day at arrival, arrival in ambulance, medication given to abort seizure activity, whether lumbal puncture (LP), magnetic resonance imaging (MRI), ultra sonography (US), computer tomography – (CT), electro cardiogram (ECG), electro encephalogram (EEG) was performed/ordered, timing and result of EEG, hospital admittance, referrals and diagnosis both in ICD code and written commentary.

Most of the variables above were registered as beforehand determined categories e.g. EEG could be classified as: no EEG recorded, normal EEG, of unclear significance, normal background but focal epileptiform activity, normal background but bilateral epileptiform activity, abnormal background and bilateral epileptiform activity, regionally abnormal background and focal epileptiform activity, a picture

compatible with an epilepsy syndrome, or as missing. For explanations of what an EEG pattern is suggestive of see table 1. Other variables were handled in an exploratory manner, by observing what was written in the charts and first thereafter categorizing the information. Among these variables were premonitory experiences, provoking factors and prior diseases.

One year follow-up variables:

Any child who, within one year, returned to the children's hospital ER, neurology outpatient clinic, general pediatric outpatient clinic, affiliated health centers where pediatricians with an interest in neurology operated, or who was hospitalized for reasons associated to the paroxysmal event was adopted in our follow up cohort.

Variables concerning; the occurrence of new seizures, number of visits at different outpatient clinics, investigations undertaken, whether anti epileptic drugs (AEDs) were prescribed, and the diagnosis the last time the child was seen during the one year follow up were extracted from the medical charts.

New composite variables were constructed e.g. whether the child had reached puberty, and whether it arrived at the ER when EEG was easily available (weekdays between eight and five). One composite variable that needs a detailed explanation is EEG during follow up. When more than one EEG was recorded it was the most recent that was chosen, if this was not performed when the child was on medication, in which case the EEG that was diagnostic was chosen. We combined both EEG variables in one. The assignment of patterns was done as follows, patterns were ranked according to severity; 1. EEG picture compatible with an epileptic syndrome 2. Pathological EEG. 3.EEG of unclear significance 4. Normal EEG 5. No EEG recorded .The highest ranking pattern was chosen. However one child had two different pathological patterns noted. The first EEG showed focal and the later bilateral epileptiform activity, the latter was chosen. Moreover, the diagnoses both at index event and at end of follow up were categorised into six categories: epilepsy, unspecified seizures, febrile seizures, provoked seizures, syncope and other.

Statistical methods

When testing for differences in proportions we used either Pearson's Chi- square Test or Fischer's Exact Test to allow for non-normal distribution. Fischer's Exact Test also allows scarce data[21].

To determine exact confidence intervals around a proportion we used a preprogrammed Excel sheet [22].

Ethical considerations

According to local regulations it is sufficient to have the administrative head of the relevant section of the hospital approve of the use of patient data in a study if the primary goal is to improve the efficiency within

the institution by aiding evaluation and planning. The head of the children's hospital approved our access to patient charts.

Results

Background variables regarding the children

Of the 161 children attending the ER 76 (47%) were boys. Median age at index event was 3.4 years (interquartile range 1.6-13 years). The age distribution has two peaks, one consisting of smaller children with febrile seizures, and a second consisting primarily of teenagers suffering from syncope (Figure 2).

Index event

There was no evident influence of time of day or weekday on the number of arrivals of patients. The pattern of arrival over the year showed noteworthy drops in February and September. However, these could be due to chance as the 95% confidence interval around an even distribution of the 161 ER visits ranges from 6 to 20 visits per month (Figure 3).

There were considerable amounts of information missing in the medical charts, and the only variables for which we are certain to have no missing information for any of the cases were whether the child arrived with ambulance, whether it received any medication or whether it was seizing on arrival.

Approximately half of the children arrived in ambulance (Table 2-3). Only a minority had seizure activity on arrival. Likewise only a minority were given medication to abort the seizure (Table 2-3). There were no statistically significant differences according to gender. Regarding age, dichotomized as pre- and post-pubertal, the a significantly larger proportion of younger children had ongoing seizure activity on arrival to the ER. Also, a significantly larger proportion of younger children were given medication.

In the descriptions of event semiology there were considerable amounts of information missing also when the event was witnessed by the person who accompanied the child to the ER (Table 4). Of the 16 children with paroxysmal events lasting more than 10 minutes seven had seizures or seizure suspect activity for more than 30 minutes, i.e. status epilepticus. Four of these children had tonic clonic seizures, one was suspected to have remaining partial seizure activity, and noteworthy is that no emergent EEG was performed [23]. Of the remaining two children one did not suffer from an epileptic seizure but experienced extra pyramidal side effect due to metoclopramide intoxication, also another child had ingested metoclopramide prior to having a sensation of cramp in her jaws; however it was conceived as a stress induced symptom.

The percentage of missing information in variables that necessitates recall as well as active request from physician was very high – prior seizure suspicious events (53%), prior development (85%), whether any pregnancy (91%) or postnatal complications (87%) occurred and gestational age (89%), if any relative had had either febrile seizures (80%) or a diagnosis of epilepsy (75%).

Investigations at index event

A significantly smaller proportion of the pre-pubertal children had a clinical neurological examination performed (Table 5).

Apart from EEG and ECG few investigations were undertaken (Table 6). In four cases a lumbar puncture was performed. The reasons stated were – one child with a suspicion of encephalitis, one child who had several seizures and remained at reaction level scale (RLS) of 2-3, and two febrile children, one with a lateralizing seizure and one with a lengthy seizure. None of the lumbar puncture samples showed signs of CNS infection.

The imaging that was performed was mostly CT. The justifications for ordering imaging were: four children had a CT because they had fallen badly when losing consciousness, two because of lateralizing features of the seizure, one child experienced a very long paroxysmal event, in one case there was a suspicion of encephalitis, one child had had a stroke in early childhood, one had absence seizures but a recent addition of "drop attacks", while one child suffered from headache and nausea. One child who had been diagnosed with bilateral subdural hematomas using CT had an MRI to determine how old these were.

At the time of the index event 46 children had an EEG ordered; 32 (70%) were performed within 24 hours, 9 (20%) within two weeks and 5 (11%) were performed even later. More than a third; 16 out of 46 (35%; 95% confidence interval 21%-50%) of the EEGs ordered at the time of the index event neither filled the criteria of the local PM nor had any reported prior suspect events. Even if one takes into account that long duration seizures, clustering of seizures and lateralizing seizures could be alarming to both doctors and parents and thus might motivate EEG, these factors occurred in only eight cases of the 16. Thus, there were still eight cases without evident reasons to perform an EEG.

A significantly larger proportion of the children($p=0.03$) received acute EEGs, within 24 hours, during office hours on weekdays than during weekends or nights.

Diagnosis

Epilepsy

Of the five children who were diagnosed with epilepsy at the time of their first hospital visit two (40%) were boys (Table 7). Median age was 6.1 years (interquartile range 4.1-12.7 years) (Figure 2). Four children

(80%) arrived with ambulance, none had ongoing seizure at arrival and one (20%) received a dose of diazepam. Concerning duration of seizures; one child (20%) had a seizure of unnoted length, two (40%) seized less than two minutes and two (40%) seized more than 10 minutes. One child had bitten his tounge, the other charts contained no information on this matter. Two children (40%) had had neurological insults in the perinatal period. These two children had lateralizing seizures. Two children (40%) experienced tonic clonic seizures, one child (20%) had no generalized motor activity i.e. absence seizures, one (20%) was described as having lost tonus and for one (20%) no description of motor activity was recorded.

All five had an EEG performed, three (60%) with normal background but bilateral epileptiform activity, one (20%) with abnormal background and bilateral epileptiform activity, one (20%) with regionally abnormal background and focal epileptiform activity (Figure 4). Three (60%) had experienced suspect prior events. Four children had no mentioning of epilepsy in the family while in one chart it read that no relative suffered from epilepsy. Four of the five EEGs were recorded in accordance with the guidelines in the above mentioned PM. Three children were diagnosed with G409 - unspecified epilepsy, one with G400 - benign childhood epilepsy and one with G403 - generalized idiopathic epilepsy and epileptic syndromes. Two children (40%) were admitted to a ward, the remaining three were referred for policlinical follow-up.

Unspecified Seizures

The group ”unspecified seizures” consisted of 14 cases of R252 - cramp and spasm, three cases of R568A - breath holding spells, and 14 cases of R568(x) - other and unspecified convulsions. Median age was 3.3 years (interquartile range 0.9- 15.3 years) (Figure 2). Roughly a third, n=11 (36%), were boys (Table 7). Almost half of the children, n=15 (48 %), arrived with ambulance, two (7%) had ongoing seizures at arrival, three (10%) received one or two doses of diazepam. As regards duration of seizure; six children (19%) had a seizure of unnoted length, 13 (42%) experienced a seizure less than two minutes long, eight (26%) between two and 10 minutes, four (13%) had a seizure lasting longer than 10 minutes. Two children (7%) had bitten their tongues, in two charts (7%) the absence of tongue biting was noted, the other charts contained no information on this matter. Four children (13%) had notes of having had neurological insults in the perinatal period, none of these had lateralizing seizures. Four children (13%) had lateralizing seizures.

Almost half of children 15 (48 %) had tonic clonic seizures, five (16%) were described as having lost tonus, three (10%) as having become stiff, four (13%) had seizures not featuring generalized motor activity and another four had no description of seizure motor activity noted. A large share of the children, n=18 (58%), had an EEG performed in connection to the index event, 11 of these (61%) were normal,

one (6%) showed normal background but focal epileptiform activity and six (33%) showed normal background but bilateral epileptiform activity (Figure 4). Five children (16%) had experienced seizure suspect prior events, eight (26%) had not and for the others no information was available. Six children (19%) had relatives with epilepsy, 16 (52%) had no mentioning of epilepsy in the family while in nine charts (29%) it read that no relative suffered from epilepsy. While 11 (61%) of EEGs were performed according to the above mentioned PM, seven (39%) were not. Furthermore six children who according to the PM were qualified for EEG did not receive one. Eight children (26 %) were admitted to a ward.

Other

The heterogeneous group of eight "other" consist of; two cases of P28.4 - other apnoea of newborn, two cases of Z03.8 - observation for other suspected diseases and conditions and three cases of Z03.9 - observation for suspected disease or condition, unspecified, and one case of R56.8 other and unspecified convulsions. One of the apnoeic children had an EEG, which was normal (Figure 4). In two of the cases of Z03.9 the doctor was suspicious of psychogenic mechanisms being at least partly responsible for the paroxysms. The remaining case of Z03.9 and the two cases of Z03.8 were instead seizures where the doctor had a suspicion of epilepsy. The children with a diagnosis of Z03.8 had EEGs performed, of which one showed normal background but bilateral epileptiform activity while the other was normal (Figure 4). The child with ICD code R56.8 was intoxicated on metoklopramid administered according to prescription and although ICD coded as R56.8 the paroxysms were most likely extra pyramidal side effects, why it is put in the category of "other". The child received both an EEG and medication to abort the seizure and a CT before the etiology of the abnormal behavior was uncovered by the medical staff.

Febrile seizures

Median age in the febrile seizure group was 22 months (interquartile range 16-27 months) (Figure 1). The number of boys among the 59 children was 26 (44%) (Table 7). A large share of the children n=41 (70%) arrived in ambulance. Seven (12%) had seizure activity at arrival and ten (17%) received medication to abort the seizure. The most frequent span of duration was between two and ten minutes n=25 (42%), 13 children (22%) had a duration of less, 7 children (12%) had a longer duration and 14 (24%) charts contained no information on duration. As to description of motor activity: 39 children (66%) had tonic clonic seizures, nine (15 %) were said to have become stiff, four (7%) as having lost tonus, another four (7%) had seizures without generalized motor activity while four (7%) had no registration of event motor activity.

Ten children (17%) had an EEG, of which nine (90%) were normal and one (10%) of unclear significance (Figure 4). Children with either long duration convulsions, convulsions at arrival, lateralized symptoms or

abnormal neurological findings were considered to have complex febrile seizures, n=13. Six (60%) of the EEGs performed on children with febrile seizures were performed on children considered to have complex febrile seizures (Table 8). Two children (3%) had lumbar punctures, none of these were suggestive of CNS infection. In 21 cases (36%) no diagnosis causing the fever was noted, in the remaining 38; pharyngitis, media otitis and unspecified viroses were the most frequent diagnoses. Notes of whether a neurological examination had been performed was lacking in 25 (42%) percent of cases. The extent of the neurological examinations varied widely from noting "no neck stiffness" to an examination assessing function of cranial nerves, motor - and sensory function, coordination and reflexes.

Provoked seizures

There were three cases initially understood as provoked seizures, two female infants and one teenage male (Table 7). The first infant suffered bilateral subdural hematoma from being battered; the other had suffered seizures and was found to have a B-vitamin deficiency thought to be causative while the teenage male had ingested narcotics as was confirmed by urine sample toxicology. Both the infant who had been battered and the teenager experienced tonic clonic seizures. The other infant was reported to have turned stiff. The girls were accepted to a ward and both received an EEG, where the child suffering from vitamin B deficiency displayed normal circumstances while the other girl's displayed normal background but bilateral epileptiform activity (Figure 4). In addition, the battered child received a MRI of the head as well as a thorough "battered child" investigation.

Syncope

Median age in the syncope group was 13.0 years and 35 out of 55 (64%) were older than the average age of the pubertal growth spurt, which was 10 and 12 years of age for girls and boys respectively [24]. Of the 55 children diagnosed with syncope 30 (55%) were boys (Table 7). Regarding the duration of the event: thirty (55%) hadve no information recorded, 22 (40%) reported a duration shorter than two minutes while 3 charts (5%) had a record of duration between two and ten minutes. Almost half n=27 (49%) reported typical lightheaded symptoms before losing consciousness, one (2%) reported heart palpitations/chest discomfort, five (9%) reported other symptoms and 22 (40%) charts contained no information on premonitory changes. Twenty two children (40%) reported a provoking factor of vasovagal nature such as prolonged standing, rapid rising or a nauseating experience. Two children reported having lost consciousness during exercise.

The motor behavior during the paroxysmal event was described as loss of tonus in 32 cases (58%), as with loss of tonus but with myoclonic jerks in six (11%), as tonic clonic in 3 (6%) and as stiff versus not generalized in one case each. In twelve charts there was no description of the motor behavior during the event. Eight children (15%) had an EEG, out of which seven (88%) was normal and one (13%) of unclear

significance (Figure 4). A majority n=45 (82%) of children had an ECG recorded, out of which 36 (80%) were normal, five (11%) abnormal but not causing the paroxysmal event and four (9%) were of unclear significance to the paroxysmal event. Four children (7%) were admitted to a ward.

Final diagnosis and management during follow up

Epilepsy

During the follow up period an additional twelve of the children were diagnosed with epilepsy giving a total of 17 (Figure 5). Ten (59%) were boys. Median age was 6.1 years (interquartile range 2.4-13.4 years). Specific diagnoses are given in table 8. One of the children who finally received a diagnosis of G40.3 was initially diagnosed as G40.9.

At the time of the index event 12 (71%) had an EEG recorded. Of the five children initially diagnosed with epilepsy three had an EEG with normal background but bilateral epileptiform activity, one had abnormal background and focal epileptiform activity, and the last one had regionally abnormal background and focal epileptiform activity (Figure 4). Four of the five children initially diagnosed with epilepsy had no additional EEGs, one did and retained the conclusion of "normal background but bilateral epileptiform activity" (Figure 6). The initial diagnoses and EEG results of the remaining seven children who had an EEG recorded at the index event but did not receive an epilepsy diagnosis were as follow below.

One child initially diagnosed with syncope who initially had an EEG of unclear significance and who later had one with normal background but bilateral epileptiform activity.Two cases classified as "other", one who initially had a normal EEG and came to have an EEG of unclear significance, and another child who initially had had normal background but focal epileptiform activity and in a later EEG normal background but bilateral epileptiform activity. Among the 12 initial EEG recipients there were also three cases of unspecified seizures, two who had only the initial EEG which showed normal background and focal respective bilateral epileptiform activity, one who had a renewed EEG and remained in the category of normal background but bilateral epileptiform changes. The child who had been abused had an initial EEG with normal background and bilateral epileptiform activity and an EEG during follow up while she was treated with AED that was normal (Figure 4, 6, 7and 8).The remaining five children also had EEGs performed, out of which two had normal background but bilateral epileptiform activity, one had an EEG compatible with an epilepsy (EP) syndrome and two had findings of unclear significance (Figure 8).

Seizure recurrences were experienced by two of the children initially diagnosed with epilepsy, two who were initially diagnosed with febrile seizures, the girl child initially diagnosed with subdural haematoma and provoked seizures, two of the children who had unspecified seizure from the start as well as all four

who had belonged to the group "other". In total, 11 children out 17 suffered recurrences. An absolute majority, 14 out of 17 (82%) received an AED. The median number of hospital visits was three with a range of one to six visits (Figure 9). Fifteen (88%) of the children were seen at neurology outpatient clinic, where the median number of visits was two (Figure 10). The children who were not seen at the neurology outpatient clinic were instead seen at an affiliated center, both these children had a diagnosis of G40.3. Seven children (41%) were seen at the ER again during the follow up period (Figure 11). During one year six children were hospitalized (Figure 12).

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Unspecified seizures

The unspecified seizure group consists of ten children. Two of the children were boys (20%). Median age was 2.4 years (interquartile range 0.7-14.8 years). Six had had EEGs recorded at the time of the index event, of which three (50%) were normal and three (50%) showed normal background but bilateral epileptiform activity (Figure 7). One of the initially normal had no additional EEGs, two had and were again found to be normal. Among the children who had EEG showing bilateral epileptiform activity two had no additional EEG while one child did have an additional EEG that once again showed normal background but bilateral epileptiform activity. During follow up another two children had an EEG resulting in one normal EEG and one EEG of unclear significance (Figure 8).

Six children (60%) had seizure recurrences. Two children received AED, these had multiple seizure recurrences but nothing epileptiform on EEG despite several investigations being performed (Figure 6). The children in the unspecified seizure group were seen at the hospital between one and six times (Figure 9). Eight children (80%) were seen at the neurology outpatient clinic, those who were not were instead seen at an affiliated centre in the region (Figure 10). The median number of hospitalizations was one, with a range of zero to four (Figure 12).

Other

At the end of one follow-up period five children were classified in the group "other" (Figure 5). The explicit diagnoses were: one case of E16.1 - other hypoglycaemia, one R23.0 - cyanosis, two cases of Z03.3 - observation for suspected nervous system disorder and one case of Z09.9 - follow-up examination after unspecified treatment for other conditions. One child (20%) was a boy. Median age was 16 months (interquartile range 0,6-9.3years).

The hypoglycaemic child had initially been diagnosed with syncope, the cyanotic child had had a diagnosis of breath holding spell. One of the cases of observation for suspect disease had counseling after a prolonged febrile seizure and the other had had twitching, possibly psychosomatic, initially diagnosed as

syncope. The ICD-code of Z09.9 was given to a child who had fainted but who also was under substantial social pressure. Three children had recurrences, the hypoglycaemic child and the two children who had received an ICD code of Z03.3. None of the children received AED. Two children (40%) were seen at neurology outpatient clinic, another two at an affiliated centre in the region and one was seen only in the ER (Figure 9-11).

Febrile seizures

After the one year follow up period seventeen children had a diagnosis of febrile seizures -R56.0 (Figure 5). Median age at index event was 23 months (interquartile range 18-27 months). Seven (41 %) were boys. Thirteen out of the initial 59 (22%) had recurrences that were seen at the ER (Figure 11).

At the index event three children had an EEG, of which two were normal and one was of unclear significance (Figure 7). Out of the 17 children with febrile seizures included in the follow up cohort seven had index seizures that could be considered as atypical febrile seizures. During the follow up period another six children had an EEG, all of which were normal (Figure 8). None were prescribed AEDs. Apart from those seen in the ER, one child was seen at the neurology outpatient clinic, another was seen at an affiliated centre (Figure 9-10). During the study period, including the index event, six children were hospitalized at least once (Figure 11).

Provoked seizures

At follow up only one child remained in the ”provoked seizure” group, the male teenager who had ingested narcotics (Figure 5). He had no recurrences or further investigations. The doctor at the affiliated centre where the boy was seen contacted social services to assist him in overcoming his substance abuse.

Syncope

At the end of follow up four children with syncope had been seen at either at the hospital ER, general pediatric services, neurology outpatient clinic or ward or affiliated pediatric centers (Figure 5). Three children (75%) were boys. Median age was 10.2 years (interquartile range 6.9-13.7 years). One child (25%) had an EEG at index event, two more children (50%) had one during follow up, all of which were normal (Figure 7and 8). Two (50%) had further fainting episodes. None were prescribed an AED. One of the children was seen in the neurology outpatient clinic, two were seen at an affiliated centre (Figure 9). None were hospitalized (Figure 12).

Discussion

First seizures constitute a differential diagnostic problem, where a lot can be achieved with diligent history taking (1-3). According to the PM at the regional hospital where our study was conducted, investigations including EEG are to be postponed until a second seizure occurs if there is not epilepsy in the family, previously known brain damage, or an abnormal neurological examination [18]. Initiating treatment at the second seizure is not considered in any way negative for the long time prognosis as compared to treating from the first seizure [25-27]. Among all presenting with a first-time seizure only 40-50% experience recurrences, and also among those showing epileptiform patterns on EEG, only 70% experience any recurrences [27]. Diagnosis before the second seizure thus risks treating children who would never have had a recurrence. Moreover 2-4% of normal children have epileptiform changes on EEG[23].

We found that even when the child was accompanied by a person who witnessed the paroxysmal event, information on important aspects of event seminology was lacking in the medical charts. This finding could be attributed to insufficient history taking and/or poor record keeping by the doctors. The first plausible explanation implies the need for an aid, such as a proforma to help the doctor remember the important features of seizure history taking. However, it is essential to acknowledge the difficulty for parents or to recall and retell accurately the details of a seizure [28]. Presumably it is even worse with a first seizure as parents are often afraid that their child is dying [29, 30]. Concerning the second explanation, it might seem unjustified to the ER doctor who is short of time to note negative findings like the absence of a tongue bite, and the importance also of these findings for later differential diagnosis should be stressed among the doctors at the ER.. To counter the difficulty of obtaining a good history from parents that are upset because of the event that has just unfolded, there was previously a first seizure outpatient clinic that saw children with a suspect first tonic clonic seizure within two weeks of the event. Moreover the clinic was staffed with personnel that had substantial practice in history taking and noting concerning paroxysmal events. There has also been good experiences from similar initiatives[3, 31]. The clinic was however shut down due to economic efficiency reasons.

Regarding the prudent use of imaging and lumbar puncture we can note that the prudence is in line with current recommendations, but that it is hard to determine if imaging was indicated in the individual case. Also CT and not MRI, as recommended, were used. This was due to issues of accessibility.

Notes of a neurological examination, defined as subheading "neurology" in the status part of the chart, was missing in 30% of the children. Also worth noticing is that the extent of the neurological examination varied widely from quite inadequately noting only the absence of neck stiffness to a more exhaustive examination including assessment of cranial nerves, motor- and sensory function, coordination and reflexes. Moreover, on a group level pre-pubertal children have fewer clinical neurological examinations performed although they, again on group level, experience more seizures that last up until arrival to the ER and receive more medication to abort seizure activity. To distinguish whether this is due to perceived

difficulties and inexperience in performing clinical neurological examination in young children or if this finding is confounded by the fact that all children with febrile seizures are in the young age group and that doctors perceive febrile seizures as so benign as not to warrant even a note of a neurological examination we look at the proportion of children who receive a neurological examination according to whether they are pre- or post-pubertal with the children with febrile seizures removed. The relationship between age and neurological examination is no longer significant at p =0,12 however we have now lost statistical power as roughly a third of the children have been left out of the calculation.

Apart from lacking notes on neurological examination in 42% of cases, charts belonging to children experiencing febrile seizures also lack information on concurrent infection in 36% of cases. Furthermore, ten children had an EEG recorded; four of these had simple febrile seizures for which it is not indicated to perform an EEG. A large share of parents and children return to the ER on experiencing a recurrence, implying that information regarding the benign nature of febrile seizures have not been stressed well enough at the time of the index event.

Two children received a diagnosis of epilepsy at the index event although our selection was first seizures only and they reported no prior seizures. The definition of epilepsy is a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures and by the neurobiological, cognitive, psychological and social consequences of this condition. The definition requires at least one epileptic seizure (4).One of these children received an EEG although according to the local PM he should not have received one. On the other hand six children in the unspecified seizure group did not obtain an EEG although it was indicated by the local PM. This reflects an imperfect observance to the local PM.

However, there are conflicting views of how useful an EEG are in evaluating a first seizure, with a predominance for the usefulness of EEG in first seizure contexts [19, 32].

Some of the children diagnosed with epilepsy deserve a more detailed account in order to illustrate some issues concerning the diagnosis and management of epilepsy. Two children were excluded from this study as they received an epilepsy diagnosis without an EEG or typical clinical history. This is clearly faulty, but as they did not receive AEDs as it is more an administrate miss-labeling than a diagnosis and management error. Two children received an epilepsy diagnosis at index event although it was their first seizure. One of them was neurologically normal and had as we understand no other indication than a pathological EEG of an enduring predisposition to generate epileptic seizures. Thus he would not have been diagnosed with epilepsy if not having received the EEG for which there was no indication according to the local PM. He had no further seizures but was prescribed AEDs. The other child suffered developmental delay and cerebral palsy and was a patient at the children's habilitation clinic which has a separate chartsystem, why she might have experienced recurrencies or received medication unknown to us. Three children with unsignificant EEG changes received an epilepsy diagnosis during follow up, one of them is said to be only suspect of having epilepsy. Two received AEDs.

On the other side two children had recurrent seizures, multiple hospitalisations and hospital visits but no EEG pathology. Clearly they had a tendency to have recurrent unprovoked seizures and yet they received no epilepsy diagnosis.However, these children received AED. This brings us to the necessity of EEG abnormalities for epilepsy diagnosis, after four consequtive interictal EEGs, 8% of children with recurrent seizures still yield no EEG abnormalities[33].The ILAE definition states that an epileptic seizure is the result of abnormal enhanced synchronicity in the brain, but it also lifts to discussion the fact that these might not be recordable with present technique[4]. Thus one would be able to diagnose the two children with recurrent seizures and no epileptiform changes on EEG with epilepsy. This would not alter management visavi AEDs as they had already been prescribed such. It might however relieve patient and parents of some anxiety. (Outside of the follow up period one of the children was diagnosed with epilepsy on clinical basis.)

AEDs were prescribed to 14 of 17 children diagnosed with epilepsy. That not all were prescribed AEDs is in congruence with current recommendations, that recommends case to case decision making and not routinely prescribing AEDs for newly presenting epilepsy [27]. As described above, AEDs were also prescribed to two children who had no epilepsy diagnosis but recurrent unprovoked seizures.

One can object to the *initial to final diagnoses* comparison that a child in a year could suffer from paroxysmal events with more than one etiology; also epileptics faint! Therefore we examined the charts to see whether the second diagnosis assigned was connected to the same/similar event or another as compared to the first. Only three out of 18 children who returned and were categorized in a new diagnosis group had two kinds of seizures.

The comparison of initial to final diagnoses can at a first glance look as if misdiagnosis is rife, but some represent the development of epilepsy from unspecified seizures or codes assigned to observation for suspect disease. However, a total of 5 children had their diagnoses revised. One diagnosis of syncope was eventually revised as epilepsy. One child who initially was thought to have provoked seizures due to vitamin B deficency is revised as unspecified seizures R56.8 as she continues to have seizures also when vitamin B levels are normalized. One diagnosis of breath holding spell wass revised as cyanosis. One child who from start was diagnosed with syncope is reevaluated as having an unspecified seizure, R56.8, but in the chart text it says that the child most probably suffers from panic attacks. Another child initially diagnosed with observation for other suspect disease Z03.8 was at reevaluation diagnosed with R56.8. However she experienced seizures that could be diverted thereby disqualifying a diagnosis of R56.8 according to ICD guidelines, as conversion seizures F44.5 should not be put under R56.8.

Moreover we have no way of knowing whether first diagnoses in children who suffer no recurrences are correct. This is not of great importance for clinical management as one can assume that there is no need for further care but rather for evaluating diagnosing practices.

Limitations

The method of selection suffers from weaknesses as is implied by the imperfect accordance of the results of the dual search instruments. Moreover, we consequently miss the children who have a single visit and a diagnosis of Z03.3-observation for suspect nervous system disease, or similar. Future studies could include Z03.3, Z03.8, Z03.9 and Z09.9 among the specified ICD codes to attain a better coverage of first paroxysmal events. Also migraine G43.9 and conversion seizures F44.5 are diagnoses that could be considered.

The follow-up time might be too short to catch some cases that would be given an epilepsy diagnosis even if most children have their recurrences within one year from the index seizure [25, 26]. Approximations of the percentage of children who have concurrent neurological disorders and/or developmental disability range between 25-45% [6]. In our study two children (11.8% CI 95% 1.5-36%) have neurological disorders and developmental disability indicating that we with this study design possibly miss out on disabled children. A plausible reason for this would be that children with developmental delay or neurological disorders already have contact with relevant caregivers and can approach these without passing through the ER. Also we are at risk to miss those who have epilepsy of more subtle onset since they will not necessarily present to the ER but rather be referred directly to neurology outpatient clinic or ward.

The children who syncopated and were followed up by cardiologists were not included among the follow up cohort as our area of interest is primarily in pediatric neurology and the diagnosis of epileptic seizures. This limits the comparability of the final diagnosis groups.

When assigning children to general diagnosis groups there is a degree of arbitrariness, as we do not strictly group the children according to ICD codes. As an example, we decided that the child intoxicated on metoclopramide should be in the group "others" although it had been given an ICD code of R56.8. We did however not reexamine all diagnoses as the information basis on which to do this was weak. In addition the cases deemed to be "provoked seizures" have rather disparate ICD-codes as the unifying factor is not captured by the ICD codes. Important to note is that the ICD framework has not been harmonized with the current ILAE terms for describing seizure etiology genetic, metabolic/structural and unknown why a study design based on the first might be difficult to compare with findings based on the latter.

Final diagnosis was arrived at during the one year follow up why there is the possibility that hospital visits, EEG and so forth are ascribed to a diagnosis that the child had not received at the time.

Conclusion

It can be hard for the doctor at the ER to ascribe a correct diagnosis to a paroxysmal event. The primary tools for establishing a correct diagnosis is a thorough history taking and clinical examination rather than investigations (2, 9-11). However, we found that important information derived from history taking is often lacking in medical charts, that clinical neurological examination is often insufficient, if at all performed or noted, while generally more investigations than recommended were performed. This implies the need of a bedside aid for doctors to guide and remind them of important aspects of history-taking and clinical examination. In the near future ILAE will publish a differential diagnoses manual that could be the starting point for developing a substantiated but locally adapted proforma.[34] Apart from needing careful examination and evaluation the heterogenous group of children presenting with first time paroxysmal events also need to be offered the best obtainable information concerning prognosis and diagnosis. The possibility of offering an outpatient first fitter clinic visit with time to talk the event through again would in specific cases complete the ER management, as it is often stressful as time is limited.

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Figure 1. Case selection, from chart review to follow up

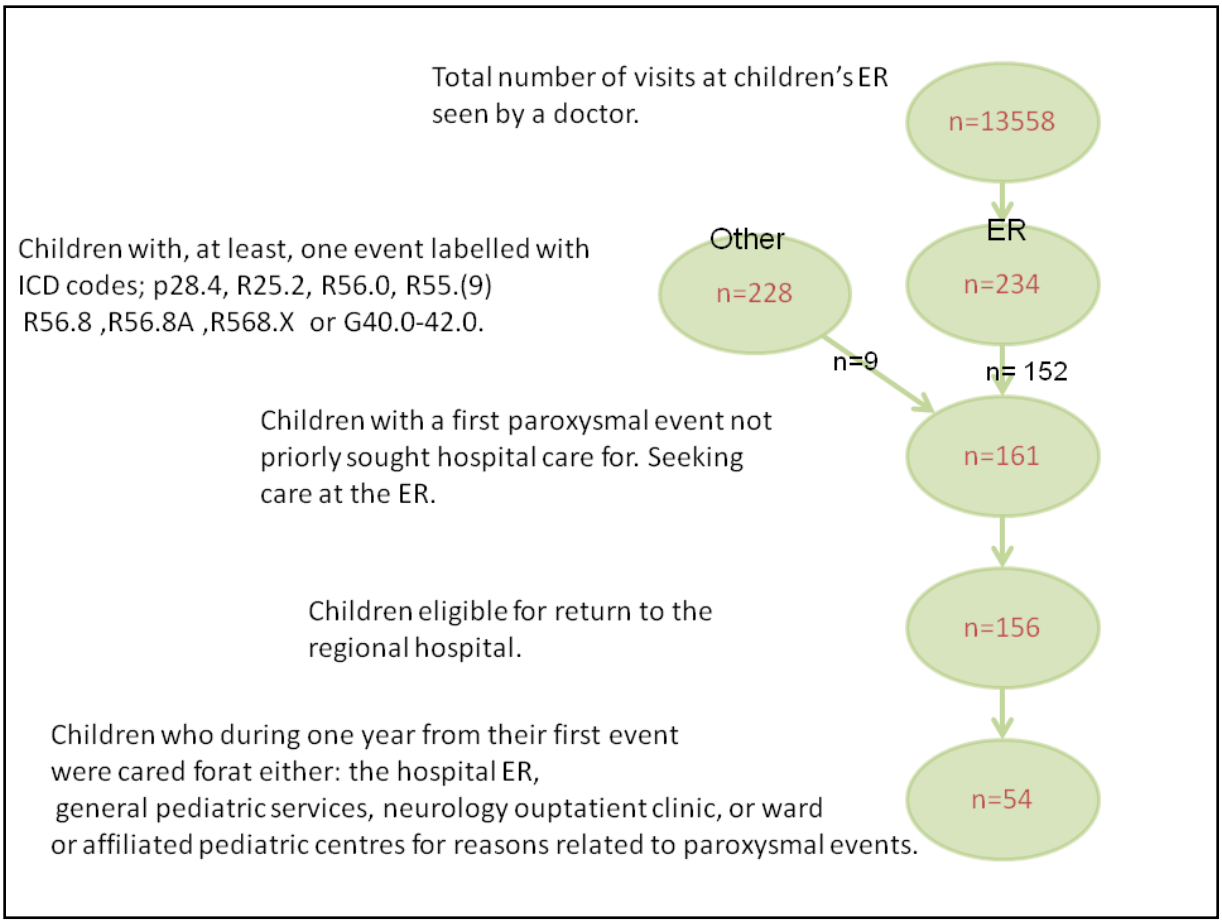


Figure 2. Age at index event in years according to initial diagnosis.

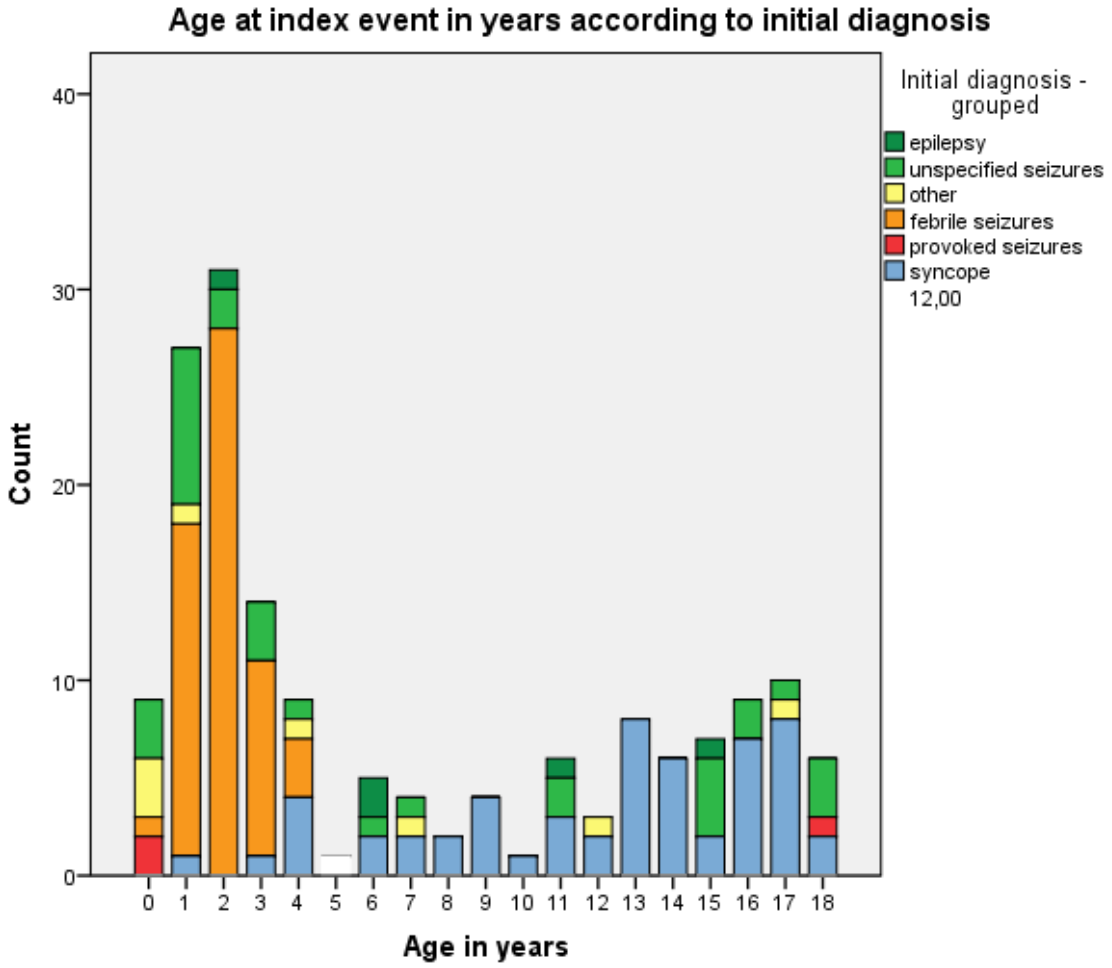
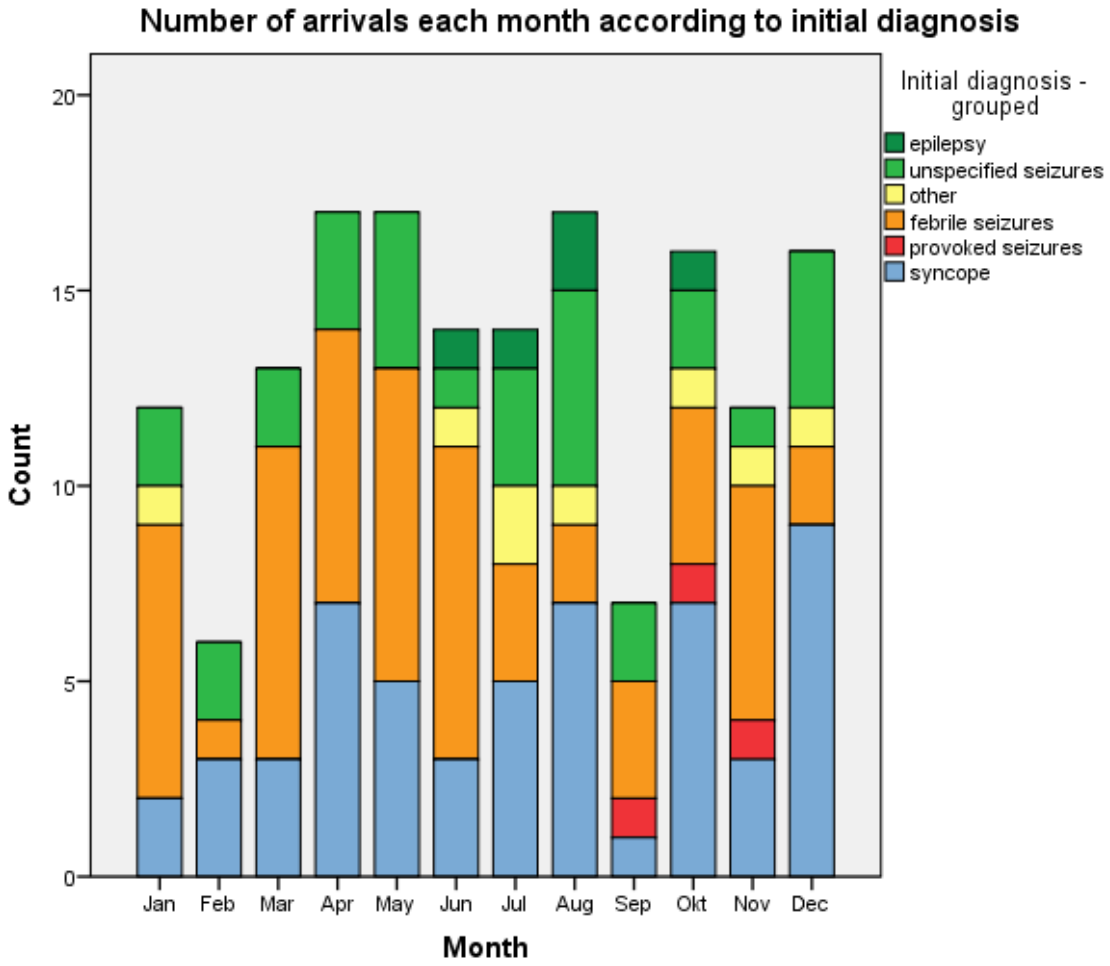


Figure 3. Number of arrivals each month according to initial diagnosis.



EEG finding	Suggestive of
Normal background focal epileptiform activity	Primary focal epilepsy
Normal background bilateral epileptiform activity	Primary generalized epilepsy
Abnormal background bilateral epileptiform activity	Symptomatic generalized epilepsy
Regionally abnormal background, focal epileptiform activity	Symptomatic focal epilepsy
Compatible with EP-syndrome	Highly specific pattern corresponding to an electroclinical syndrome e. g. hypsarrythmia and West syndrome
EEG finding of unclear significance	Neither distinctively epileptiform nor normal

Table 1. Categorization of EEG findings and what they are suggestive of.

	Boy (%)	Girl (%)	Total (%)	P-value
Arrived in ambulance				
Yes	43 (57%)	43 (50%)	86 (53%)	
No	33 (43%)	42 (49%)	75 (46%)	0.47[1]
	76 (100%)	85 (100%)	161 (100%)	
Received medication				
Yes	6 (8%)	9 (11%)	146 (91%)	
No	70 (92%)	76 (89%)	15 (9%)	0.56
	76 (100%)	85 (100%)	161 (100%)	
Ongoing seizure activity at arrival				
Yes	3 (4%)	8 (9%)	11 (7%)	
No	73 (96%)	77 (91%)	150 (93%)	0.17[1]
	76 (100%)	85 (100%)	161 (100%)	

[1]Pearson's Chi-square test

Table 2. Arrival in ambulance, seizure activity at arrival and medication given according to gender.

	Pre-pubertal (%)	Post-pubertal (%)	Total (%)	P-value
Arrived in ambulance				
Yes	59 (53%)	27 (54%)	86 (53%)	
No	52 (47%)	23 (46%)	75 (46%)	0.92[1]
	111 (100%)	50 (100%)	161 (100%)	
Received medication				
Yes	15 (13%)	0 (0%)	15 (9%)	
No	96 (87%)	50 (100%)	146 (91%)	0.006
	111 (100%)	50 (100%)	161 (100%)	
Ongoing seizure activity at arrival				
Yes	11 (10%)	0 (0%)	11 (7%)	
No	100 (90%)	50 (100%)	150 (93%)	0.014
	111 (100%)	50 (100%)	161 (100%)	

[1]Pearson's Chi-square test

Table 3. Arrival in ambulance, seizure activity at arrival and medication given according to age, dichotomized at average age of pubertal growth spurt.

	Accompanied by a person who witnessed the event			
	Missing	No	Yes	Total
Duration				
Missing info	8 (44%)	19 (65%)	28 (25%)	55 (34%)
≤2min	7 (39%)	6 (21%)	38 (33%)	51 (32%)
2≥10 min	2 (11%)	2 (7%)	35 (31%)	39 (24%)
≥10min	1 (6%)	2 (7%)	13 (11%)	16 (10%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)
Consciousness				
Missing info	2 (11%)	1 (3%)	5 (4%)	8 (5%)
Conscious	1 (6%)	1 (3%)	7 (6%)	9 (6%)
Uncounscious	15 (83%)	27 (93%)	102 (90%)	144 (89%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)
Motor activity				
Missing info	6 (33 %)	11 (38%)	9 (8%)	26 (16%)
Not generalized	2 (11%)	0 (0.0%)	7 (6%)	9 (6%)
Tonic Clonic	2 (11%)	5 (17%)	55 (49%)	62 (39%)
Loss of tonus	6 (33%)	11 (38%)	22 (22%)	39 (25%)
Loss of tonus with jerks	2 (11%)	1 (3%)	3 (3%)	6 (4%)
Stiff	0 (0%)	1 (3%)	15 (12%)	16 (10%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)
Lateralisation				
Missing info	13 (72%)	18 (62%)	15 (13%)	46 (29%)
No lateralisation	5 (28%)	11 (38%)	85 (75%)	101 (63%)
Sided symptoms	0 (0.0%)	0 (0.0%)	14 (12%)	14 (9%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)
Colour				
Missing info	18 (100%)	20 (69%)	69 (60%)	107 (66%)
Normal	0 (0%)	3 (10%)	7 (6%)	10 (6%)
White	0 (0%)	3 (10%)	11 (10%)	14 (9%)
Blue	0 (0%)	2 (7%)	27 (24%)	29 (18%)
Red	0 (0%)	1 (3%)	0 (0%)	1 (1%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)
Eyes				
Missing info	17 (94%)	27 (93 %)	75 (66%)	119 (74%)
Open	1 (6%)	2 (7%)	39 (34%)	42 (26%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)
Tounge bite				
Missing info	16 (89%)	25 (86%)	104 (91%)	145 (90%)
No bite	1 (6%)	2 (7%)	10 (9%)	13 (8%)
Bite	1 (6%)	2 (7%)	0 (0%)	3 (2%)
	18 (100%)	29 (100%)	114 (100%)	161 (100%)

Table 4. Event semiology according to whether a person who witnessed the event accompanied the child to the ER

	Pre-pubertal	Post-pubertal	Total	p-value
No neurological examination	40 (36%)	8 (16%)	48 (30%)	
Neurological examination	71 (64%)	42 (84%)	113 (70%)	0.010*
	111 (100%)	50 (100%)	161 (100%)	

Table 5. Neurological examination noted according to pre- and post-pubertal age.

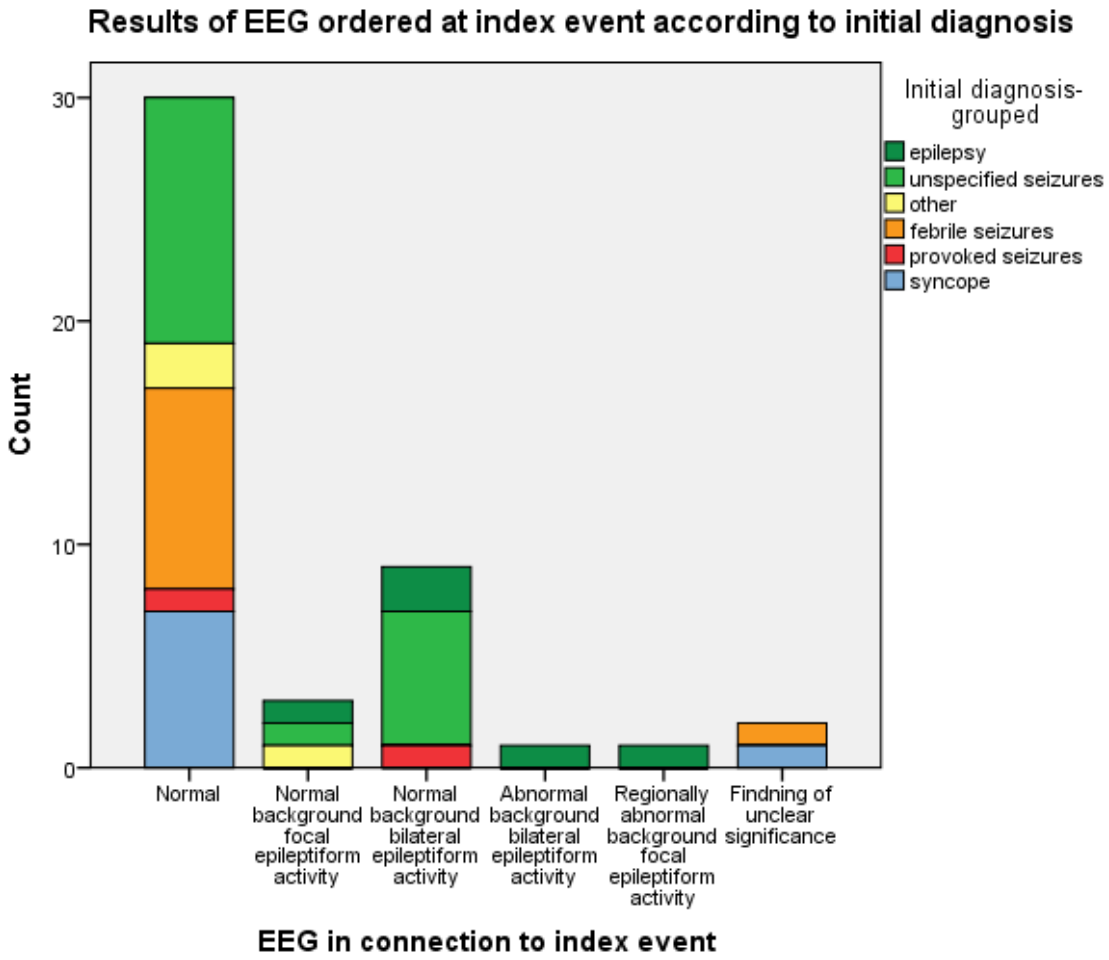
Investigation	Frequency (%)
Lumbar puncture	
Not performed	157 (97 %)
Performed, no signs of CNS infection	4 (3%)
	161 (100%)
Computer tomography	
Not performed	150 (93%)
No abnormality	9 (6%)
Abnormality	1 (1%)
Unclear significance	1 (1%)
	161 (100%)
Magnetic resonance imaging	
Not performed	160 (99%)
Abnormality	1 (1%)
	161 (100%)
Ultra sound	
Not performed	160 (99%)
No abnormality	1 (1%)
	161 (100%)
ECG	
Not performed	105 (65%)
Normal ECG	47 (29.%)
Abnormal but not causing paroxysmal event	5 (3.%)
Unclear significance	4 (3%)
	161 (100%)
EEG	
Not performed	115 (71%)
Normal	30 (19%)
Normal background focal epiletiform activity	3 (2%)
Normal background bilateral epileptiform activity	9 (6%)
Abnormal background bilateral epileptiform activity	1 (1%)
Regionally abnormal backgroundfocal epileptiform activity	1 (1%)
EEG finding of unclear significance	2 (1%)
	161 (100%)

Table 6. Investigations performed or ordered at index event, and their results.

Diagnosis	Boys (%)	Total	(%)
Epilepsy	2 (3%)	5	(3%)
Unspecified seizures	11 (15%)	31	(19%)
Other	6 (8%)	8	(5%)
Febrile seizures	26 (34%)	59	(37%)
Provoked seizures	1 (1%)	3	(2%)
Syncope	30 (39%)	55	(34%)
Total	76 (100%)	161	(100%)

Table 7. Initial diagnosis according to gender

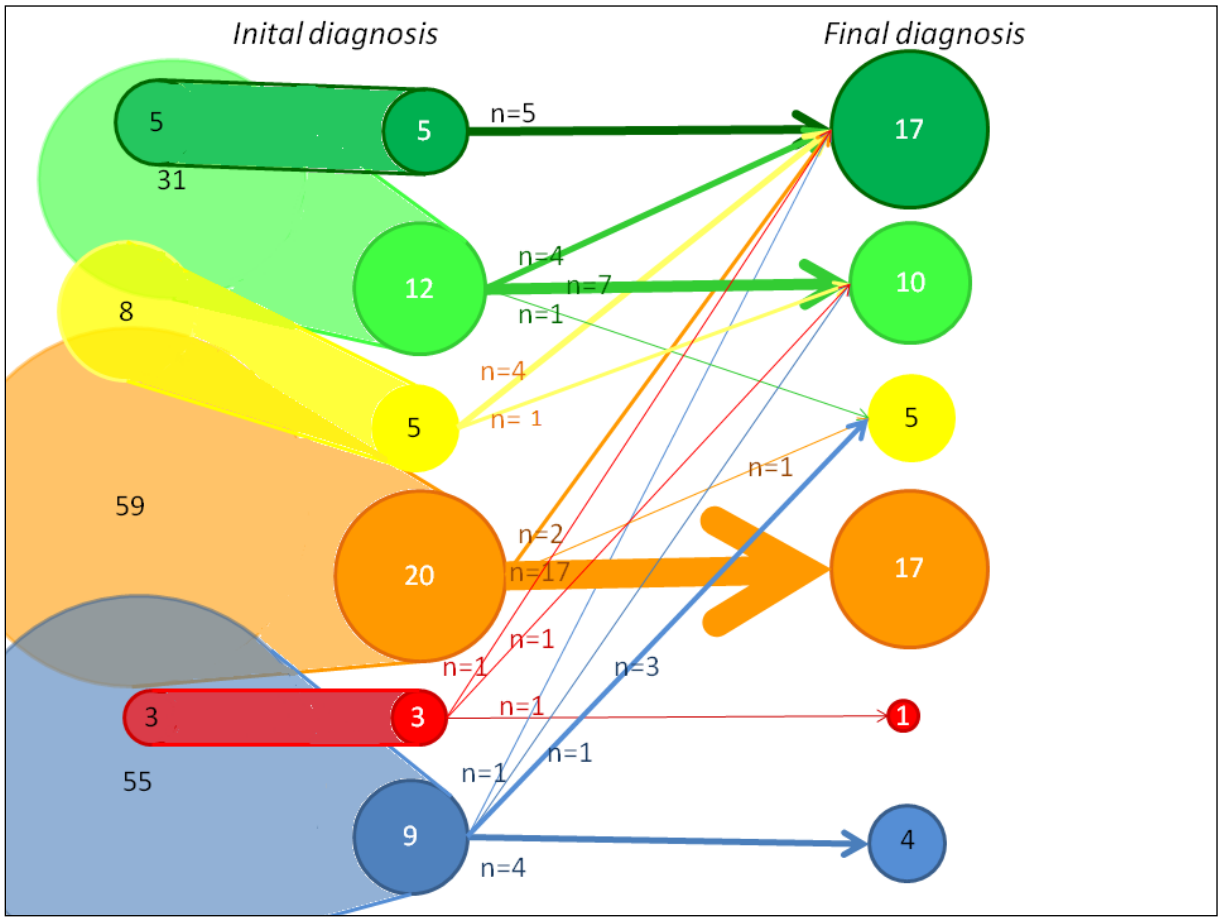
Figure 4. Results of EEG ordered at time of index event according to initial diagnosis

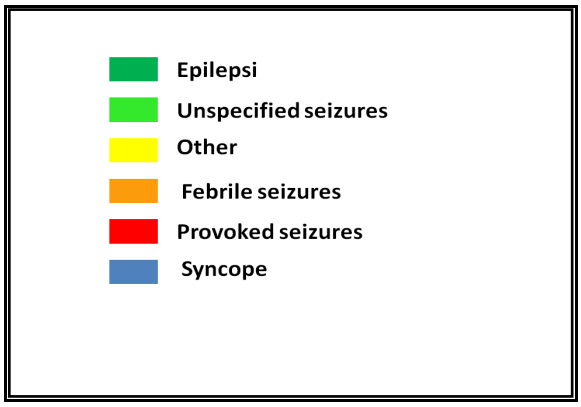


	Simple febrile seizure (%)	Complex febrile seizure (%)	Total (%)
EEG ordered at index event	4 (9%)	6 (46%)	10 (17%)
No EEG ordered at index event	42 (91%)	7 (54%)	49 (83%)
	46 (100%)	13 (100%)	59 (100%)

Table 8. EEG recorded at index event according to simple or complex febrile seizure

Figure 5. Comparison of initial and final diagnoses, where size corresponds to number of children and light colours indicate all who received a diagnosis at index event while bright colours indicate those who were a part also of the follow up cohort





ICD-code	Definition	Children (n)
G40.0	Localization-related (focal)(partial) idiopathic epilepsy and epileptic syndromes with seizures of localized onset	2
G40.1	Localization-related (focal)(partial) symptomatic epilepsy and epileptic syndromes with simple partial seizures	1
G40.2	Localization-related (focal)(partial) symptomatic epilepsy and epileptic syndromes with complex partial seizures	2
G40.3	Generalized idiopathic epilepsy and epileptic syndromes	4
G40.8	Other epilepsy	1
G40.9	Unspecified epilepsy	7
		17

Table 9. Number of children according to epilepsy ICD codes at follow-up, listed with their definitions.

Figure 6. Number of children receiving zero, one, two, three or four EEGs during one year according to final diagnosis.

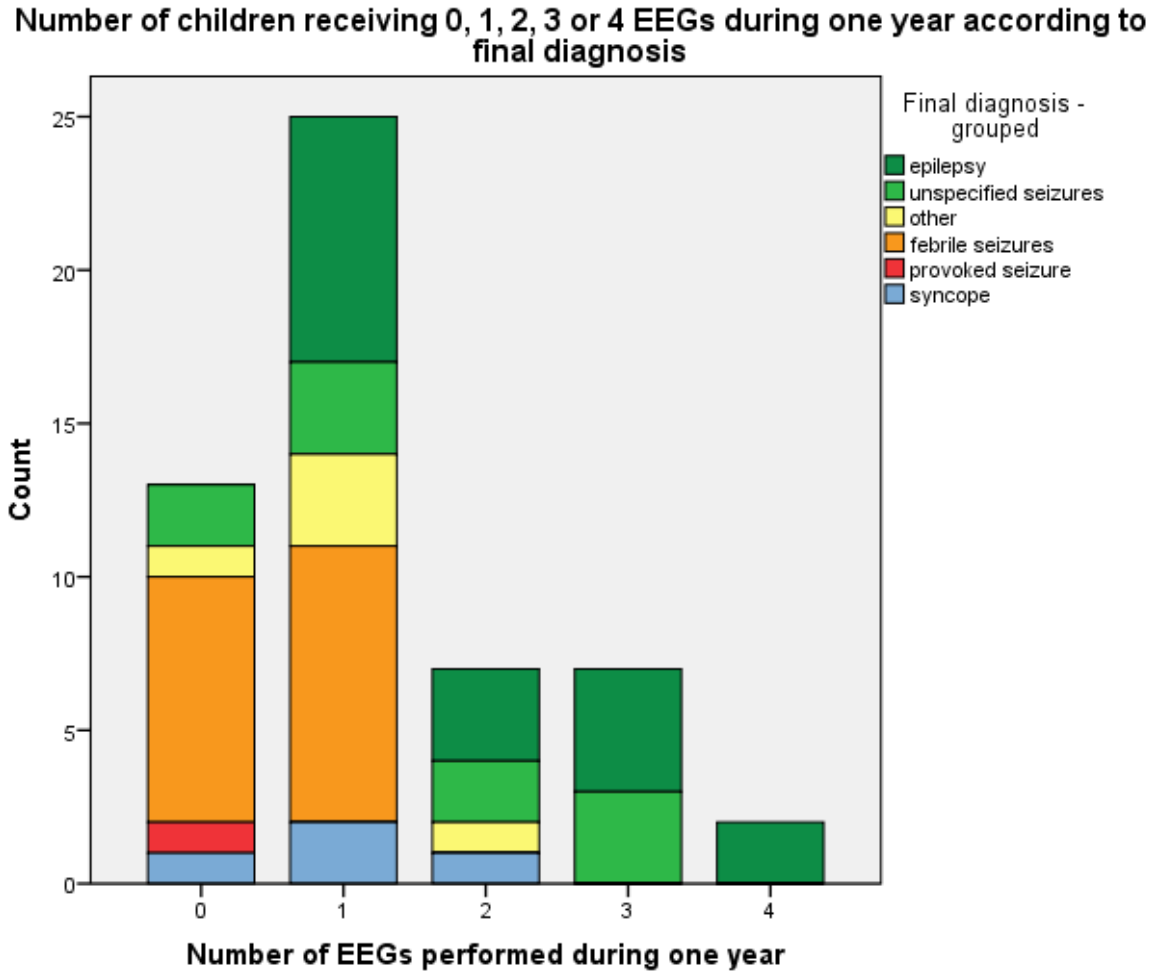


Figure 7. Results of EEGs ordered at index event according to final diagnosis.

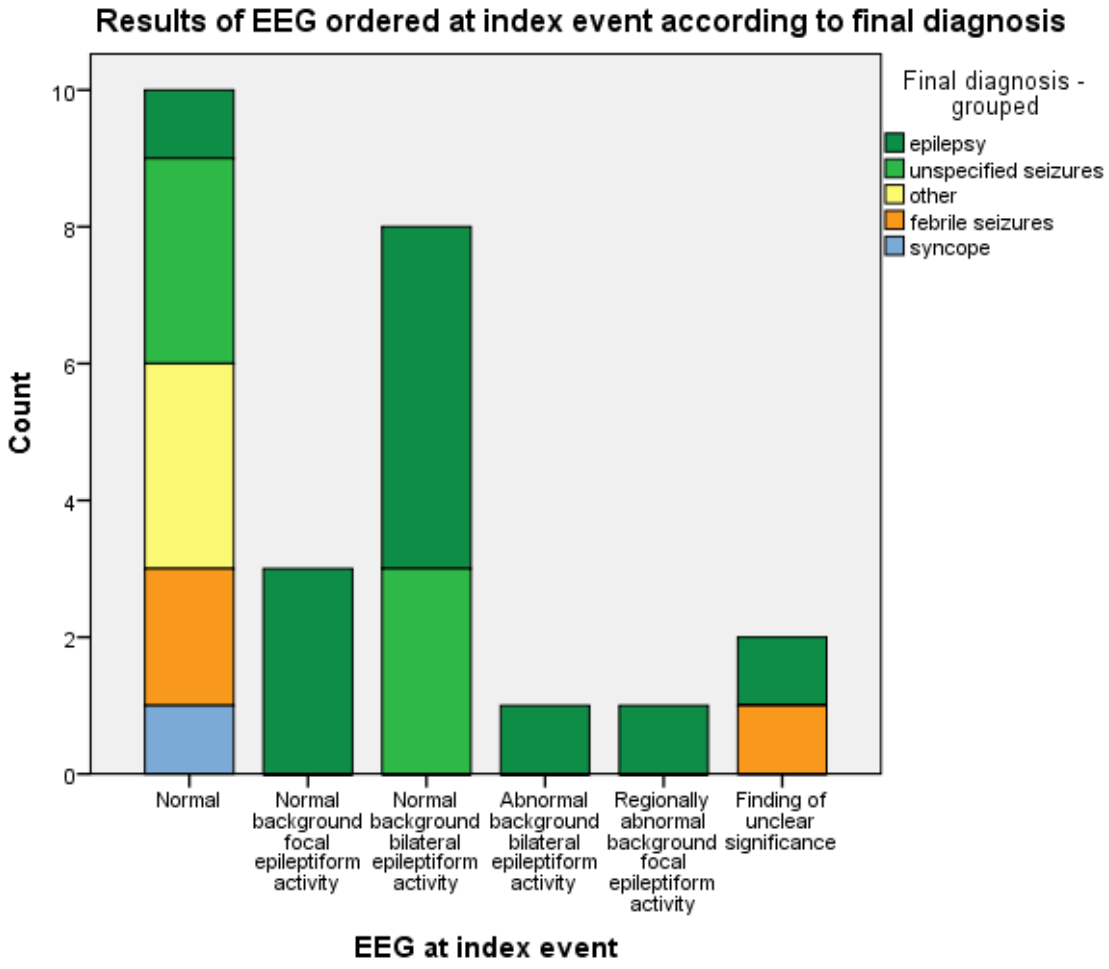


Figure 8. Results of EEG ordered during the follow-up period event according to final diagnosis.

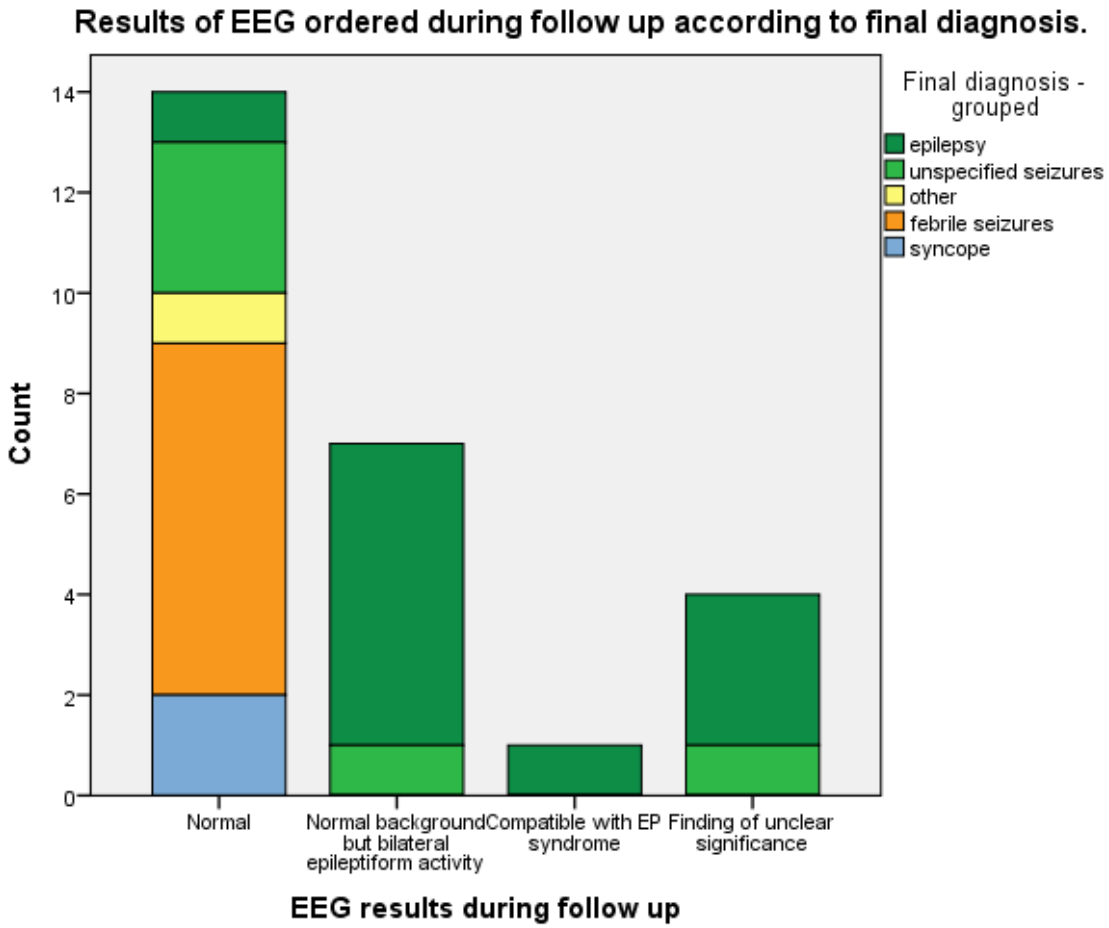


Figure 9. Total number of visits to the hospital during the follow up period according to final diagnosis.

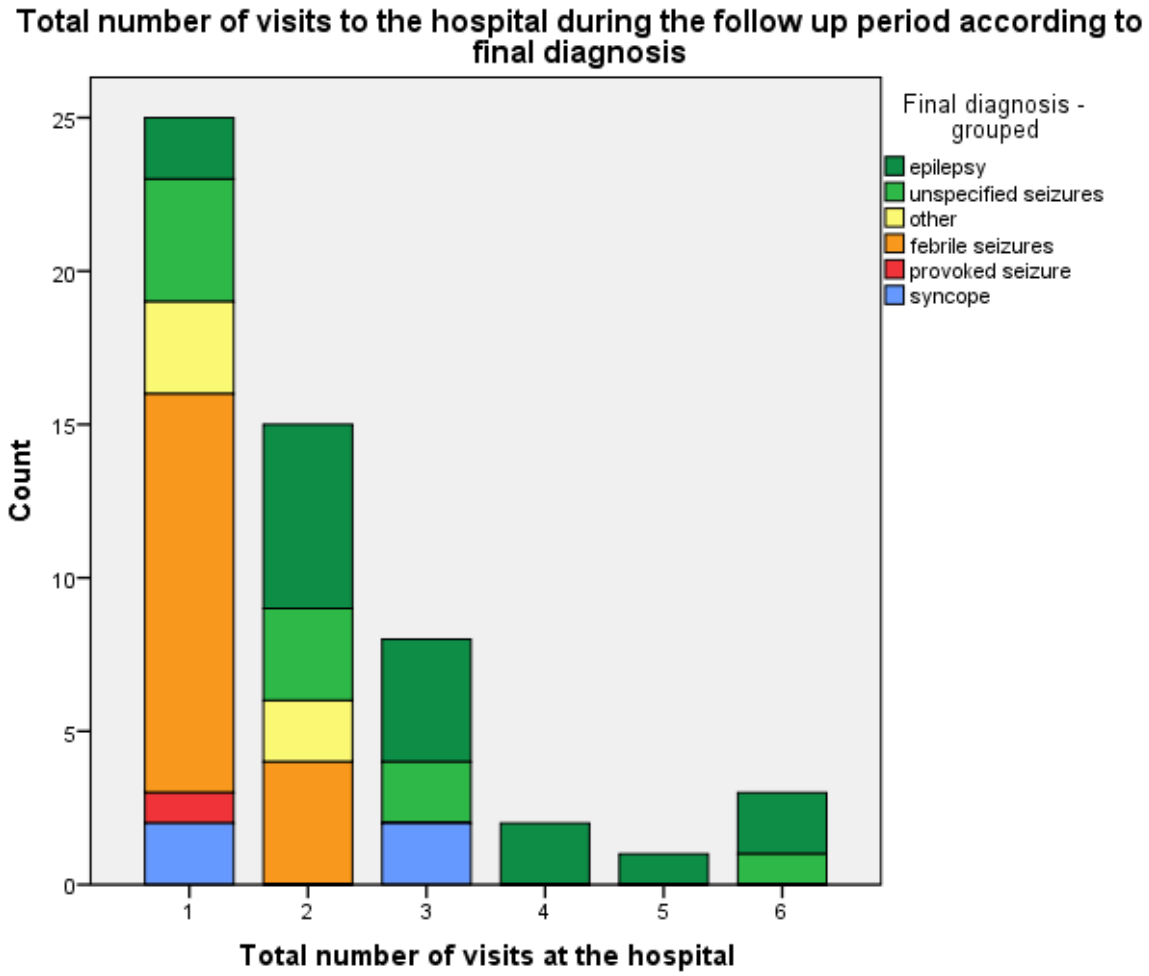


Figure 10. Number of visits to the neurology outpatient clinic during the follow up period according to final diagnosis.

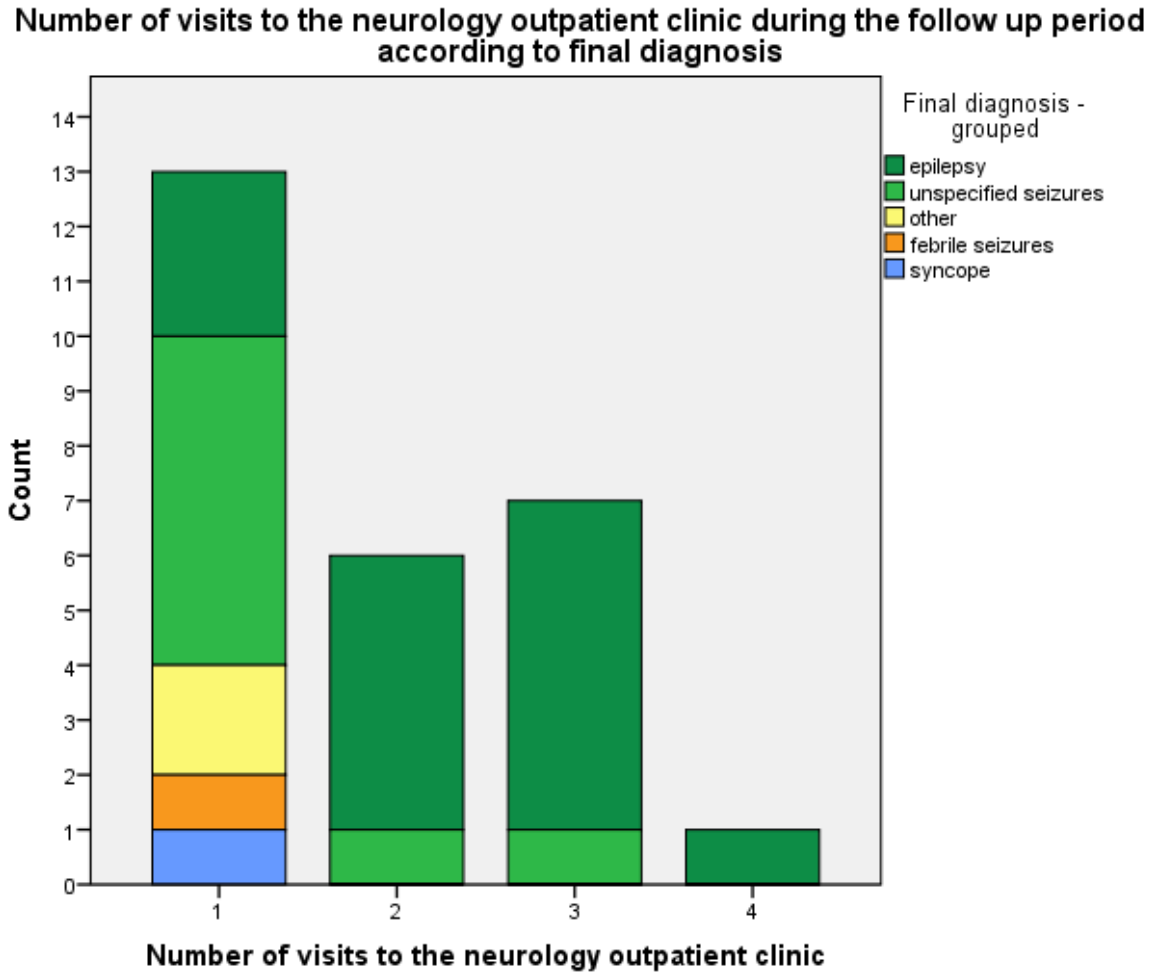


Figure 11. Number of visits to the ER during the follow up period according to final diagnosis.

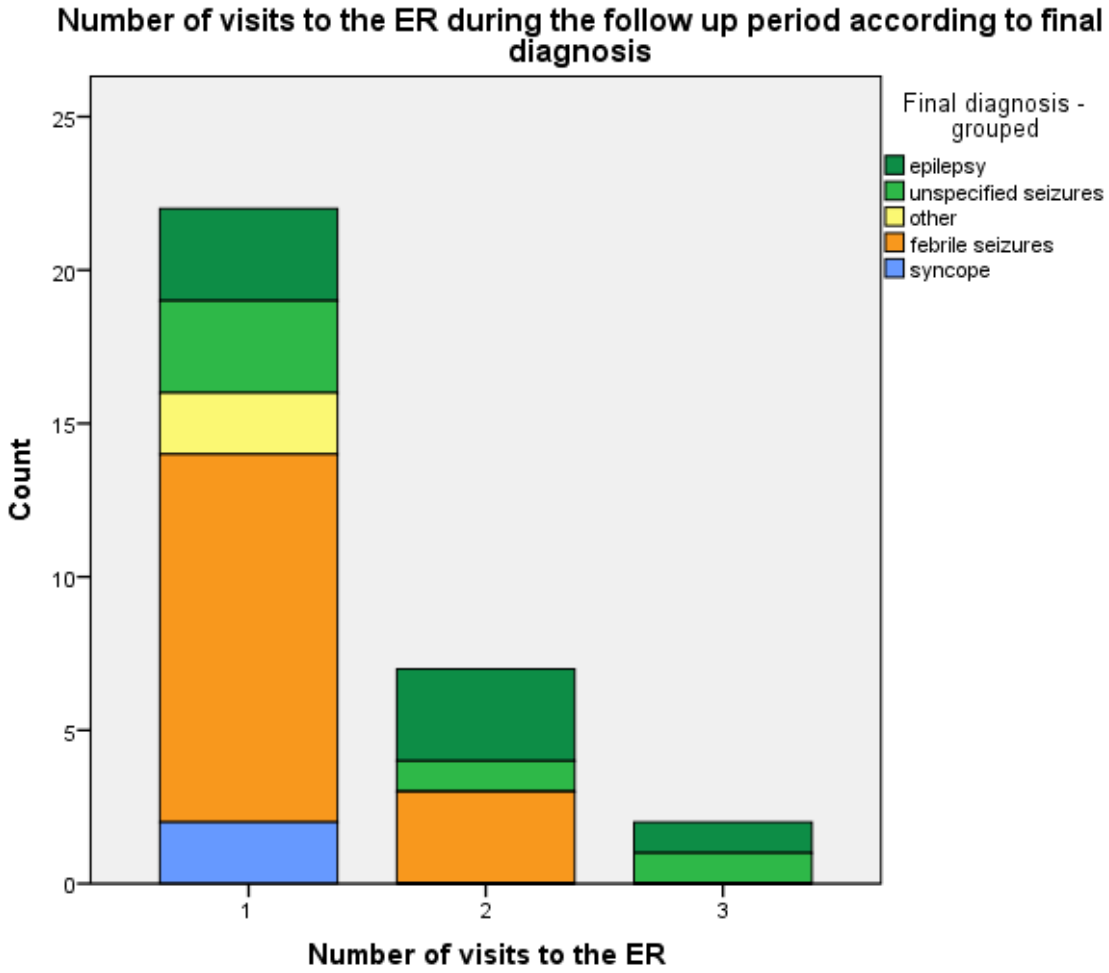


Figure 12. Total number of hospitalisations according to final diagnosis.