Unprovoked Status Epilepticus: The Prognosis for Otherwise Normal Children With Focal Epilepsy

**WHAT'S KNOWN ON THIS SUBJECT:** The outcome of status epilepticus in children depends on the etiology. In otherwise normal children who have ≥1 episodes of unprovoked status epilepticus as part of the evolution of their epilepsy, the seizure and intellectual outcome is unclear.

**WHAT THIS STUDY ADDS:** Based on population-based data and 20 to 30 years’ follow-up of normal children with focal epilepsy, one-third with status epilepticus had recurrence of status. Reassuringly, intelligence, seizure control, and rate of remission were not altered compared with those without status epilepticus.

**abstract**

**OBJECTIVE:** To document the effect of unprovoked status epilepticus (SE) on the prognosis for otherwise normal children with focal epilepsy.

**METHODS:** From the Nova Scotia Childhood Epilepsy Study (population-based), we identified patients with focal epilepsy, normal intelligence, and neurologic examination and follow-up ≥10 years. We compared those with and without unprovoked SE.

**RESULTS:** One hundred eighty-eight cases had a mean follow-up of 27 ± 5 years with no deaths from SE. Thirty-nine (20%) had SE, 19 of whom experienced their first seizure. The number of episodes of SE was 1 in 27 patients (69%) and 2 to 10 in 12 patients. At onset 9 of 39 (23%) SE patients and 35 of 149 (23%) no-SE patients had specific learning disorders. At follow-up, 11 (28%) SE and 49 (33%) no-SE patients had learning disorders (P = not statistically different [ns]). Grades repeated, high school graduation, and advanced education did not differ. The number of antiepileptic drug (AED) used throughout the clinical course was the same: 22/39 (56%). SE patients used ≤2 AEDs versus 99 of 149 (64%) no-SE patients (P = .2). The distribution of patients using 3 to 11 AEDs was similar. The remission rate (seizure-free without AEDs at the end of follow-up) for SE patients was 24 of 39 (61%) versus 99 of 149 (66%) in no-SE (P = .5). Intractable epilepsy occurred in 15% SE and 11% of no-SE cases.

**CONCLUSIONS:** SE often recurs but apparently has little influence on long-term intellectual and seizure outcome in normally intelligent children with focal epilepsy. *Pediatrics* 2012;130:e501–e506

**AUTHORS:** Peter Camfield, MD, and Carol Camfield, MD

Department of Pediatrics, IWK Health Centre and Dalhousie University, Halifax, Nova Scotia, Canada

**KEY WORDS**

status epilepticus, children, epilepsy, prognosis

**ABBREVIATIONS**

AED—antiepileptic drug
ns—not statistically different
SE—status epilepticus

Both authors have been involved in every stage of the research (study idea and theme, study design, data acquisition, data analysis, and data interpretation). We have both worked on the drafting of the article and its revisions and have approved the version to be published. There are no further investigators who have had a significant role in this study.

www.pediatrics.org/cgi/doi/10.1542/peds.2012-0838
doi:10.1542/peds.2012-0838

Accepted for publication May 14, 2012

Address correspondence to Peter Camfield, MD, and Carol Camfield, MD, IWK Health Centre, 5850 University Ave, Halifax, Nova Scotia, Canada B3K 6R8. E-mail: camfield@dal.ca

PEDiATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2012 by the American Academy of Pediatrics

**FINANCIAL DISCLOSURE:** The authors have indicated they have no financial relationships relevant to this article to disclose.

**FUNDING:** No external funding.
There is an abundant literature that documents the adverse effects of convulsive status epilepticus (SE)\(^1\)\(^2\)\(^3\) although clinical evidence indicates that most children with an episode of SE recover unchanged after an episode of treated SE.\(^4\)\(^5\) SE is considered to be a medical emergency with a quick response deemed critical, even though the cause of the SE is by far the most important predictor of outcome.\(^6\)\(^7\) Acute symptomatic SE from disorders such as encephalitis or head injury is often followed by serious, permanent neurologic deficits. Children with epilepsy may have unprovoked SE. In a sense, the SE is just a long one of their seizures. It is less certain how much influence SE has on the clinical outcome in these children because of the confounding effects of different epilepsy syndromes and degrees of preexisting neurologic comorbidities.\(^8\) However, in our experience, parents are typically extremely upset because convulsive SE treatment in a child with epilepsy implies ambulance transport and emergency care. After the SE has stopped, there are 4 main issues regarding prognosis: the recurrence risk, the possibility of brain injury from the SE, the risk of less successful seizure control, and the influence of SE on long-term remission.

In this article, we have attempted to answer these issues about prognosis with data from the Nova Scotia Childhood Epilepsy population-based cohort. For clarity, we have elected to study the largest, easily recognized group children with epilepsy: otherwise normal children with focal epilepsy.\(^9\) Our study is restricted to convulsive SE.

**METHODS**

Cases of SE were selected from the Nova Scotia Childhood Epilepsy population-based cohort.\(^9\) SE was defined in the conventional way: \(>30\) minutes of unconsciousness with a continuous convulsive seizure or repeated shorter convulsive seizures without return of consciousness between seizures for \(>30\) minutes.\(^6\)\(^10\) Consciousness was determined by parents and physicians in the clinical setting and was without a rigorous definition. All of the episodes of SE were unprovoked, and none were acute symptomatic or febrile.

The methodology for the Nova Scotia Childhood Epilepsy population-based cohort has been described in several previous articles.\(^9\)\(^11\)\(^12\) In Nova Scotia, physicians reported that they always request an EEG when a child presents to the health care system with an unexplained seizure. Therefore, the initial case finding method was clinical reports from a central EEG reading facility for the Province of Nova Scotia. Medical records were then reviewed, and nearly every child had been seen by a pediatric neurologist. When there was doubt about the diagnosis, we contacted the family directly for more details. In this fashion, we were able to identify all children with newly diagnosed epilepsy (\(\geq2\) unprovoked seizures) in Nova Scotia between 1977 and 1985. We had had intermittent contact with these families and patients since that time. In 2009–2011, we recontacted patients and often their parents to gather data for this article.

Eligible patients were 1 month to 16 years of age at the time of their second unprovoked seizure and residents of Nova Scotia for at least the first 2 seizures. SE could have occurred as the first unprovoked seizure or at any time in the subsequent course. For this study, all patients experienced only focal seizures (includes focal with secondary generalization) through their entire clinical course. Patients were included if their overall intelligence was judged to be normal and their neurologic examination did not reveal any problems sufficient to interfere with activities of daily living. Follow-up had to be at least 10 years from the date of their first seizure. Patients were excluded if they had generalized seizure types or mental handicap. Specific learning disorders with preserved overall intelligence (IQ \(>70\)) were permitted. More than 90% of those with specific learning disorders had this impression confirmed with standard psychometric testing. A wide variety of psychometric testing was carried out at many ages by different psychologists, particularly in the school system and less often by tertiary-level neuropsychologists. Therefore, we have not provided details.

Data were analyzed by using that statistical package SPSS version 15.0. \(\chi^2\) was used for nonparametric comparisons and \(t\) tests for parametric data with 1-tailed tests on the grounds that it is unlikely that SE improves outcome. Statistical significance was defined as \(P \leq .05\).

**RESULTS**

In the overall cohort, 254 patients were potentially eligible for study; however, 66 had a follow-up \(<10\) years and were excluded. The remaining 188 (74%) met all of the eligibility criteria and had a follow-up of \(>10\) years and are the subjects for this report. There were 107 male and 81 female patients with an average follow-up of 27.8 ± 5 (SD) years. For all cases, we reviewed the medical records. Additional information came from the patient only (21%), a parent only (8%), the patient plus a parent (62%), other sources such as spouse (4%), and chart only (13%). One patient in the original cohort died of SE, but his death occurred only 14 months after the onset of epilepsy, and therefore, he was not eligible for this study. There were no additional deaths from SE.

There were 39 eligible patients with SE (17 male and 22 female patients) and 149 without SE. SE occurred for the first time at an average age of 112 ± 93 months (range 4–340) and was the first seizure in 20 (51%) patients. For those with SE that was not at onset,
the interval from onset of epilepsy to SE averaged 71 months (range 2–212 months). All patients came to a hospital emergency department for treatment of their SE, although in many, the SE was over by the time of assessment. All 20 patients with SE as their first seizure were hospitalized. When SE occurred later in the clinical course, 15 of 19 were hospitalized. Nearly all patients were treated with benzodiazepines, some received intravenous phenytoin or phenobarbital. No patient had refractory SE status to the point of requiring anesthesia or barbiturate coma.

Table 1 shows the demographic characteristics for the SE and non-SE groups and details of their seizure and intellectual outcome. Using all of the information available through the clinical course, the cause of epilepsy remained unknown in 53% of those with SE and 68% in those without SE ($P = .2$).

### Number of Episodes of SE

Overall, 27 (69%) had a single episode of SE and 12 (31%) had more: 7 had 2 episodes of SE, 3 had between 3 and 5, and 2 had 10. Four of the 20 (20%) with SE as their first seizure had $\geq 1$ recurrence of SE as did 8 of the 19 (49%) with a first episode of SE occurring later in the course of their epilepsy ($P = .25$).

### Brain Injury

Details of cognitive function are shown in Table 2. Based on our inclusion criteria, all patients were judged to be of normal intelligence at seizure onset. Between the onset and the end of follow-up, no patient developed mental retardation or neurologic deficits sufficient to interfere with activities of daily living. At onset, the proportion diagnosed with a specific learning disorder was 23% in both the SE and non-SE groups (formal psychometric testing unavailable in only 1 case). By the end of follow-up, learning disorder was noted in 28% of the SE group and 33% of the non-SE group ($P = ns$). Rates of repeated school grades, special schooling arrangements, high school graduation, and technical/community college and university graduation were the same in both groups. Earned income at the end of follow-up (a possible reflection of cognitive abilities) was the same in both groups.

### Seizure Control

The course of epilepsy was similar in the SE and non-SE groups (Table 1). Fifty-one percent of those with SE as their first seizure had $\geq 1$ recurrence of SE as did 8 of the 19 (49%) with a first episode of SE occurring later in the course of their epilepsy ($P = .25$).

Table 1 Patient Demographics and Details About Their Epilepsy Course

<table>
<thead>
<tr>
<th>Age of epilepsy onset</th>
<th>SE ($n = 30$)</th>
<th>No SE ($n = 149$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5 ± 4.4 y (0.3–15.6)</td>
<td>7.4 ± 4.3 y (0.2–15.8)</td>
<td></td>
</tr>
<tr>
<td>Age at follow-up</td>
<td>33.8 ± 7.7 y (15–47.9)</td>
<td>35.4 ± 7 y (12.5–46.6)</td>
</tr>
<tr>
<td>Length of follow-up</td>
<td>27.8 ± 5.3 y (11.9–33.1)</td>
<td>28 ± 4.9 y (10.9–37.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Epilepsy syndrome</th>
<th>SE (%)</th>
<th>No SE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial complex seizures</td>
<td>0</td>
<td>0 (94%)</td>
</tr>
<tr>
<td>1–10</td>
<td>1</td>
<td>21 (53%)</td>
</tr>
<tr>
<td>11–20</td>
<td>2</td>
<td>17 (41%)</td>
</tr>
<tr>
<td>21–99</td>
<td>5</td>
<td>11 (25%)</td>
</tr>
<tr>
<td>&gt;100</td>
<td>11</td>
<td>13 (29%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of AEDs used throughout clinical course</th>
<th>SE (%)</th>
<th>No SE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12 (31%)</td>
<td>64 (43%)</td>
</tr>
<tr>
<td>2</td>
<td>10 (26%)</td>
<td>32 (21%)</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>32 (25%)</td>
</tr>
<tr>
<td>4–6</td>
<td>6</td>
<td>17 (20%)</td>
</tr>
<tr>
<td>7–11</td>
<td>3</td>
<td>11 (12%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average longest time seizure-free</th>
<th>SE (n = 30)</th>
<th>No SE (n = 149)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 ± 10.5 y (range 0–31.7)</td>
<td>19.4 ± 10.3 y (range 0–36.4)</td>
<td></td>
</tr>
<tr>
<td>During longest time seizure-free, average time seizure-free on AEDs</td>
<td>4.8 ± 6.6 y (range 0–30)</td>
<td>4.3 ± 5.1 y (range 0–25.8)</td>
</tr>
<tr>
<td>During longest time seizure-free, average time seizure-free without AEDs</td>
<td>13.5 ± 15.3 y (range 0–31.3)</td>
<td>16 ± 10.4 y (range 0–32.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remission at the end of follow-up</th>
<th>SE (%)</th>
<th>No SE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off AEDs, seizure-free: 20</td>
<td>25 (67%)</td>
<td>55 (37%)</td>
</tr>
<tr>
<td>Off AEDs, still having seizures: 9</td>
<td>10 (33%)</td>
<td>9 (6%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intractable epilepsy at the end of follow-up</th>
<th>SE (%)</th>
<th>No SE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off AEDs, seizure-free: 24</td>
<td>40 (70%)</td>
<td>98 (65%)</td>
</tr>
<tr>
<td>Off AEDs, still having seizures: 20</td>
<td>20 (38%)</td>
<td>20 (13%)</td>
</tr>
</tbody>
</table>

(Rates of repeated school grades, special schooling arrangements, high school graduation, and technical/community college and university graduation were the same in both groups. Earned income at the end of follow-up (a possible reflection of cognitive abilities) was the same in both groups.)
were in remission ($P = \text{ns}$). The length of terminal remission after successfully discontinuing AED treatment was $13.5 \pm 15.3$ years in the SE group and $16 \pm 10.4$ years in those without SE ($P = \text{ns}$).

Because there is concern that SE in children $<2$ years of age may have a more sinister outcome, we selected children with epilepsy onset $\leq 2$ years for additional analysis. There were only 3 patients with an episode of SE before age 2 years (4, 14, and 16 months). None of these patients had recurrent SE, and their intellectual and seizure outcomes were similar to those whose seizure onset was at $\geq 2$ years but never had an episode SE.

**DISCUSSION**

For otherwise normal children with epilepsy characterized by focal seizures, $\geq 1$ episodes of convulsive SE did not have a significant effect on their long-term seizure or intellectual outcome compared with those without status. Those with SE were more likely to have at least 1 secondarily generalized seizure. However, large numbers of this seizure type were the same in both groups. Our patients should be clearly distinguished from those with acute symptomatic SE in which the etiology is the major determinant of the outcome.\(^6,7\)

We do not have data about what might have precipitated SE in our patients, such as sleep deprivation or poor medication adherence.

Others have noted that SE in children with epilepsy has a recurrence risk of $\sim 10\%$ to $20\%$.\(^8,13\) The effect of these episodes of SE on seizure outcome has generally been noted to be minor. A careful systematic review of the literature suggested that “The effect of an episode of convulsive SE on the course of epilepsy is unclear.”\(^6\) Details of the effect of SE on intellectual outcome in otherwise normal patients with focal epilepsy have not been extensively reported. A well-known population-based Finnish epilepsy cohort followed for many years only included 11 patients with SE and no other neurologic problems.\(^15\) These 11 children had similar educational outcomes to those without SE. Most previous studies have either focused on SE as a first seizure and the risk of subsequent epilepsy or the influence of SE in children with epilepsy.\(^15-18\) Unprovoked SE as a first seizure does not increase the risk of recurrent seizures (epilepsy) more than a short first seizure.\(^14,15\) In a study of children in Connecticut who had developed a wide spectrum of epilepsy syndromes and then an episode of SE, there was a slight increase in the risk of intractability.\(^18\) Our study is of similar size but focused on a more homogenous group of children with epilepsy (otherwise normal with focal seizures). Even with a longer follow-up, we did not find an increase in intractable epilepsy after SE.

Our findings should not encourage a lackadaisical approach to the treatment of SE as the first seizure or in children with established epilepsy. Because of indisputable reports of children who have suffered irreversible brain damage from long SE, we continue to encourage prompt treatment to stop long seizures, particularly convulsive seizures. All of our patients had their episode of SE in the context of a health care system that permitted prompt access to emergency care in an era when the use of parenteral or rectal benzodiazepines was the norm. We were not able to document the total length of SE for most of our patients, although in all cases, we judged that the seizure duration was at least 30 minutes. Even when the medical record suggested a precise length of seizure, we suspect that there would be many errors. In our clinical experience, the exact time of the onset is often unclear, and the exact time when the seizure stopped is often difficult to determine unless there is simultaneous EEG

### Table 2: Cognitive Outcome

<table>
<thead>
<tr>
<th></th>
<th>SE ($n = 39$)</th>
<th>Non-SE ($n = 149$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal intelligence</td>
<td>39 (100%)</td>
<td>149 (100%)</td>
</tr>
<tr>
<td>Learning disorder</td>
<td>9 (23%)</td>
<td>35 (23%)</td>
</tr>
<tr>
<td>At follow-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning disorder</td>
<td>11 (28%)</td>
<td>49 (33%)</td>
</tr>
<tr>
<td>Formal psychometric testing</td>
<td>20</td>
<td>79</td>
</tr>
<tr>
<td>School grade repeated</td>
<td>14 (36%)</td>
<td>70 (47%)</td>
</tr>
<tr>
<td>Extra help at school, resource</td>
<td>15 (39%)</td>
<td>73 (49%)</td>
</tr>
<tr>
<td>Work/study program at school</td>
<td>4 (10%)</td>
<td>13 (9%)</td>
</tr>
<tr>
<td>Stimulant medication</td>
<td>4 (10%)</td>
<td>16 (11%)</td>
</tr>
<tr>
<td>High school graduation</td>
<td>28 (72%)</td>
<td>104 (70%)</td>
</tr>
<tr>
<td>University education</td>
<td>12 (31%)</td>
<td>36 (24%)</td>
</tr>
<tr>
<td>Technical school or community college</td>
<td>13 (33%)</td>
<td>48 (31%)</td>
</tr>
<tr>
<td>Lowest income*</td>
<td>10 (26%)</td>
<td>49 (33%)</td>
</tr>
<tr>
<td>Highest income</td>
<td>11 (28%)</td>
<td>51 (34%)</td>
</tr>
</tbody>
</table>

* For patients no longer in school, total family income (patient + partner) at the end follow-up was assigned to 1 of 3 groups: low (at or below the poverty line), medium (between the poverty line and the upper 25th percentile), high (above 25th percentile), based on Statistics Canada estimates for Nova Scotia.

Follow-up 27, no longer received AED treatment, 8 received monotherapy, and 4 received 2 AEDs.

The average longest time seizure-free through the entire clinical course was also similar between the 2 groups (SE $17 \pm 10.5$ years and non-SE $19.4 \pm 10.3$ years). Table 1 shows that during this period of seizure-freedom the average time with and without AED treatment did not differ between the groups.

During follow-up, epilepsy surgery was undertaken in 3 (8%) of the SE group and 9 (6%) of those without SE. At the end of follow-up, the proportion of patients with intractable epilepsy (a seizure at least every 3 months and trials of $\geq 3$ AEDs at maximum tolerated dose) was the same in both groups: 6 of 39 (15%) in the SE group versus 17 of 149 (11%) in the non-SE group.\(^9\)

**Long-term Remission**

Remission was defined as seizure-free and no longer receiving AEDs. At the end of follow-up, 24 (61%) of the SE group and 99 (66%) of the non-SE group
recording. This clinical reality limits all studies that might attempt to compare the length of SE with the outcome. Nonetheless, SE lasting several hours appears more likely to injury the brain than shorter SE.17

Our study was limited to children without intellectual or neurologic deficit before their first seizure. Psychometric testing was administered at various ages with various tests. Other measures of academic outcome such as grades repeated, requirement for special schooling arrangements, post-secondary education, and eventual employment were not associated with SE, making it unlikely that we under-estimated the rates of specific learning disorder in the status group. All children had focal epilepsy, although only 13.3% had a recognized benign focal epilepsy syndrome. Because MRI was not available at the time that our cohort was assembled, we do not know how many of our patients had an identifiable brain lesion to explain the cause of their epilepsy. Based on CT scanning (available in 86% of our cases) and clinical information (obtained through-out follow-up), ~60% had no identifiable cause found for their epilepsy. These patients would fall in the broad category of cryptogenic partial epilepsy,18 although the term cryptogenic has recently been discouraged.19 In the 2010 proposed epilepsy classification scheme, they would be identified as focal epilepsy, cause unknown with the additional features of normal intelligence and neurologic examination.19 We hope that the group of patients who we have studied are easily recognized. It may be incorrect to extend our findings to other epilepsy syndromes or categories of epilepsy.

The number of cases of SE in our study was relatively modest so that rare poor outcomes cannot be excluded. We limited our cases to children without global intellectual deficits before their first seizure. There have been few studies of patients who have had psychometric testing before and after seizures or SE. The National Collaborative Perinatal Project study did report standard psychometric testing in a prospective study of >50 000 newborns followed to age 7 years.20 There were 62 patients without previous seizures when they under-went psychometric testing at age 4 years. Between age 4 and 7 years, they had ≥1 unprovoked seizures, although it is unclear how many seizures they had or how severe they were and if any constituted SE.21 Psychometric testing was repeated at age 7 years. The results at age 4 and 7 were identical. Dodrill described adults with chronic epilepsy who had pre- and post-SE psychometric testing.22 He did recognize some new deficits, but the findings were subtle, and it is not clear how many other nonstatus seizures these patients had between their psychometric assessments. Roy et al reported neuropsychological testing in a highly selected group of infants who had a prolonged febrile seizure. They were found to have some problems with executive functioning compared with a small number of controls. Unfortunately, there was no preseizure testing, and therefore it is not possible to attribute a cause-and-effect relationship between the febrile status epilepticus.23

CONCLUSIONS

We conclude that the prognosis for otherwise normal children with focal epilepsy is apparently not significantly altered by unprovoked SE. The risk of recurrence of SE appears to be ~30%. Significant brain injury is unlikely in a geographic setting with good access to prompt treatment of SE. The clinical course (ease of seizure control and risk of intractable epilepsy) and chance of remission are unchanged. The overall message to parents and caretakers about SE should be one of reassurance.

REFERENCES

3. Shorvon S. Does convulsive status epilepticus (SE) result in cerebral damage or affect the course of epilepsy—the epide-miological and clinical evidence? Prog Brain Res. 2002;135:85–95
Unprovoked Status Epilepticus: The Prognosis for Otherwise Normal Children With Focal Epilepsy
Peter Camfield and Carol Camfield
Pediatrics 2012;130;e501; originally published online August 20, 2012;
DOI: 10.1542/peds.2012-0838

Updated Information & Services
including high resolution figures, can be found at:
/content/130/3/e501.full.html

References
This article cites 22 articles, 7 of which can be accessed free at:
/content/130/3/e501.full.html#ref-list-1

Citations
This article has been cited by 1 HighWire-hosted articles:
/content/130/3/e501.full.html#related-urls

Subspecialty Collections
This article, along with others on similar topics, appears in the following collection(s):
Developmental/Behavioral Pediatrics
/cgi/collection/development:behavioral_issues_sub

Permissions & Licensing
Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
/site/misc/Permissions.xhtml

Reprints
Information about ordering reprints can be found online:
/site/misc/reprints.xhtml

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2012 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.