Nonconvulsive Seizures in the Pediatric Intensive Care Unit: Out of Sight, Out of Mind?

Nonconvulsive Seizures in the Pediatric Intensive Care Unit: Etiology, EEG, and Brain Imaging Findings. Saengpattrachai M, Sharma R, Hunjan A, Shroff M, Ochi A, Otsubo H, Cortez MA, Carter Snead O III. *Epilepsia* 2006;47(9):1510–1518. PURPOSE: To determine the occurrence of nonconvulsive seizures (NCS) in the Pediatric Intensive Care Unit (PICU); to ascertain the relationship of NCS to past medical history, etiology, EEG, and brain imaging; and to determine the concordance between abnormal EEG findings and neuroimaging abnormalities. METHODS: A retrospective review was conducted of all pediatric patients who were admitted or transferred to the PICU from January 2000 to December 2003 with an unexplained decrease in level of consciousness, no overt clinical seizures, and EEG recordings performed within the 24 hours of onset of an altered state of consciousness. RESULTS: Twenty-three of 141 patients who met criteria for inclusion in the study (16.3%) were found to have NCS. The male-to-female ratio was 1.9:1. The largest group of patients (43%) had no preexisting neurological condition prior to the onset of NCS. In the remainder, the etiology of NCS included: acute structural brain lesion (48%), acute nonstructural brain lesion (22%), epilepsy-related seizure (13%), and others (17%). Epileptic foci were lateralized to the right side in 39.2%, the left side in 30.4%, and were bilateral in 30.4%. Of 23 patients with NCS, 18 (78.3%) demonstrated abnormal neuroimaging. In 10 of 18 of these patients (55.6%), the findings on neuroimaging were concordant with the lateralization found on EEG ($p < 0.05$, Fisher's exact test). CONCLUSIONS: NCS are not uncommon in pediatric patients with an altered state of consciousness. Almost half of the patients were previously healthy especially if they were under 6 months of age. This report highlights the importance of clinical awareness of NCS in the PICU.

Nonconvulsive Status Epilepticus in Children: Clinical and EEG Characteristics. Tay SK, Hirsch LJ, Leary L, Jette N, Wittman J, Akman CI. *Epilepsia* 2006;47(9):1504—1509. BACKGROUND: Nonconvulsive status epilepticus (NCSE) is a highly heterogeneous clinical condition that is understudied in the pediatric population. OBJECTIVE: To analyze the epidemiological, clinical, and electroencephalograpic features in pediatric patients with NCSE. METHODS: We identified 19 pediatric patients with NCSE

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from the epilepsy database of the Comprehensive Epilepsy Center at Columbia University between June 2000 and December 2003. Continuous EEG monitoring was analyzed and chart review was performed. RESULTS: The patients ranged from 1 month old to 17 years of age. Five patients developed NCSE following convulsive status epilepticus (CSE), and a further 12 patients developed NCSE after brief convulsions. Two developed NCSE as the first manifestation during a comatose state following hypoxic events. Acute hypoxic-ischemic injury was the most frequent etiology of NCSE in our population (5 of 19; 26%), followed by exacerbation of underlying neurometabolic disease (4 of 19; 21%), acute infection (3 of 19; 16%), change in antiepileptic drug regimen (3 of 19; 16%), refractory epilepsy (2 of 19; 11%), and intracranial hemorrhage (2 of 19; 11%). Six patients had associated periodic lateralized epileptiform discharges (PLEDs), one had generalized periodic epileptiform discharges (GPEDs). Five (5 of 19; 26%) patients died of the underlying acute medical illness. Periodic discharges were associated with worse outcome. CONCLUSIONS: The majority of our patients with NCSE had preceding seizures in the acute setting prior to the diagnosis of NCSE, though most of these seizures were brief, isolated convulsions (12 patients) rather than CSE (five patients). Prolonged EEG monitoring to exclude NCSE may be warranted in pediatric patients even after brief convulsive seizures. Prompt recognition and treatment may be necessary to improve neurological outcome.

COMMENTARY

Although the magnitude of risk associated with nonconvulsive seizures (NCS) is controversial, laboratory studies (1) and clinical experience (2) suggest that these seizures can result in neurological injury, especially if they are prolonged. Furthermore, the clinical manifestations related to NCS, including confusion, lethargy, and unresponsiveness are likely to be mistakenly attributed to alternative causes, leading to unnecessary evaluations, prolonged intensive care unit stays, and inappropriate interventions. Thus, the finding of NCS as a cause of a patient's encephalopathy could have a major impact not only on their intensive care unit management but on their long-term management as well. The prevalence of NCS in critically ill adults has been described recently in reports that make it clear that this entity has been underrecognized (3,4). However, the prevalence and clinical features of NCS in children had not been addressed until Saengpattrachai et al. and Tay and colleagues reported on the extent of the problem of unrecognized NCS in hospitalized children, as reviewed here. At first glance, their findings appear to be partially discrepant but this discrepancy likely reflects the fact that the studies use different technologies and evaluate slightly different clinical questions.

Saengpattrachai and colleagues obtained routine EEG studies (lasting at least 30 minutes) from pediatric patients who were transferred to the intensive care unit for a reduced level of consciousness. None of 141 patients was found to be in nonconvulsive status epilepticus, though a significant minority had NCS that were frequent enough to be captured during the brief studies. EEG seizures were usually focal, often with concordant neuroimaging. Treatment appeared to abolish the seizures, as documented by follow-up routine EEG studies.

Tay et al. addressed the question of which patients in the pediatric intensive care unit are at risk for nonconvulsive status epilepticus by monitoring all patients using continuous EEG (lasting at least 12 hours) and then determining which patients met specific EEG criteria for nonconvulsive status epilepticus. As the authors note, the EEG criteria were tightly defined so as to ensure that the patients included had continuous electrographic seizures. The criteria may well have led to exclusion of some patients who had frequent seizures yet did not quite meet the rigid EEG standards for nonconvulsive status epilepticus. They found that 10% of all monitored patients were in nonconvulsive status epilepticus. They assessed the clinical setting, EEG patterns, imaging, and outcome in patients meeting the EEG criteria for nonconvulsive status epilepticus. Most (but not all) patients with nonconvulsive status epilepticus had observed convulsive seizures at some time during hospitalization prior to the diagnosis, though only three had been in convulsive status epilepticus. Most had identifiable, acute precipitants. The EEG pattern was variable but included rhythmic epileptiform discharges or rhythmic slowing, which was focal in all but four patients.

As each group notes, the studies do not allow for definitive conclusions on the prevalence of NCS or nonconvulsive status epilepticus in the pediatric intensive care unit. Both studies are limited by retrospective analysis and the potential for selection bias. For example, it is likely that the patients in the Tay et al. study underwent continuous EEG monitoring based on clinical factors suggesting a heightened risk for seizures. If all patients with unexplained encephalopathy were monitored, the "hit rate" might have been lower than 10%. However, it also is likely that continuous nonconvulsive seizure activity is more common than one would think based on the report of Saengpattrachai and colleagues. As these authors state, the brief EEGs may have failed to identify times when electrographic seizure activity became continuous. In fact, one patient had an 11-minute seizure during the routine EEG study. In light of these pediatric studies and similar studies in adults (3,4), it seems plausible that frequent NCS, including nonconvulsive status epilepticus, contribute to the clinical findings in a significant minority of children with unexplained encephalopathy.

In addition to supporting the possibility that NCS may be a commonly unrecognized cause of cognitive deterioration in children, these reports may help formulate an approach to evaluating children with unexplained encephalopathy. While a routine EEG recorded for at least 30 minutes appeared adequate to make a diagnosis in the patients studied by Saengpattrachai and colleagues, it is impossible to know whether additional patients would have been identified with longer recording sessions. A pragmatic approach would be to start with a routine EEG but to consider a continuous 24-hour recording in patients at high risk for ongoing NCS, such as those who have had previously observed convulsive seizures. Both groups found that the NCS were variable in EEG pattern but most often focal. Thus, EEG monitoring for detection of NCS should typically include full international 10–20 electrode placements rather than expedient alternatives that are less spatially sensitive.

All patients demonstrating NCS were treated, leading to resolution of the previously unrecognized seizures. As the authors for both studies note, this finding does not allow one to draw conclusions as to the magnitude of benefit that the patients derived from having an accurate diagnosis. Given the evidence that NCS can result in permanent neurological dysfunction (2), however, it seems prudent to aggressively identify patients with this readily treatable condition.

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