Evidence-Based Protocols in Child Neurology

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KEYWORDS

• Child neurology • Evidence-based medicine • Treatment guidelines
• Practice parameters

KEY POINTS

- Medical care is delivered across systems that vary in complexity.
- Evidence-based guidelines are based on the scientific method.
- Creating guidelines ensures the delivery of quality care and improves patient outcomes.
- Guidelines in Child Neurology have been created for the major problems encountered: status epilepticus, ICU EEG monitoring, neonatal neurology, stroke, traumatic brain injury, and brain death.

The practice of medicine has advanced but become more complex because of science. In the United States, the science-based foundation of medicine started with the creation of the Johns Hopkins University School of Medicine, modeled on German universities that used a science-based foundation for medical education: the discovery of new knowledge, rather than teaching what was already known.[1] Other schools followed this model. The 1910 Flexner Report led to the standardization of medical training in the United States with the closing of schools that did not adhere to these standards.[2,3]

Yet, these scientific advances have resulted in more complex medical care. More is known about a given disorder: its pathophysiology, pathology, genetics, and treatments, and the addition of basic science research and clinical trials makes it difficult for the individual physician keep up and interpret this.[4] The development of the multiple subspecialties evolved from this. Hospitals have become more complex, moving from a single general hospital to subspecialty units within the individual hospital to hospital systems with inpatient and outpatient care delivered in many locations.

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The need to provide quality medical care and improve outcomes has become important. Even remuneration will depend on outcomes in the future. Two initiatives are important in this endeavor: evidence-based medicine (EBM) and quality improvement initiatives. EBM is defined as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients."[5] This evidence is based on research, and EBM has become the foundation of medical care. Quality improvement is defined as "the degree to which health care services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[6]

The Neurology and Neurocritical Care Services at Texas Children's Hospital (TCH) provide an example of this situation. TCH has 3 inpatient units, a main campus and 2 satellite campuses, with 55 child neurologists, including 20 epileptologists. Neurology inpatients and intensive care units (ICUs) are present in all 3 locations staffed by different neurologists. We also have a dedicated neurocritical care service that provides the neurology consultations to the various ICUs. The dedicated neurologic ICU is staffed by pediatric critical care medicine specialists interested in the brain and neurologists interested in neurocritical care. Patients with neurologic insults are seen in other dedicated ICUs and multidisciplinary pediatric ICUs in our system. We must ensure that the same quality neurologic care is delivered across the multiple settings within our network; this can only be done by following a standard guideline or treatment protocol for a specific disorder.

Various terms are used for these standardization modalities including practice guidelines, practice parameters, or practice standards. Practice standards are authoritative, whereas guidelines are recommendations. Practice standards are established by an authority or general consent; these are typically done for accreditation and established by an organization. Clinical practice guidelines are systematically developed statements based on evidence and current data, used to help standardize medical care and improve the quality of care.[7,8] Evidence-based refers to using scientifically based research to generate these guidelines. Practice guidelines have also evolved out of national health policy because of 3 major factors: rising health care costs, practice variations, and reports of inappropriate care.[9–11]

The evidence-based process for neurology and child neurology has been driven by the American Academy of Neurology (AAN) and the quality standards committee of the Child Neurology Society (CNS). Guidelines have been created for screening, diagnosis, causation, prognosis, and treatment. Evidence and recommendations are classified, according to the type of study: therapeutic, effectiveness, causation, prognostic accuracy, diagnostic screening, and population screening. Evidence has 4 levels, which refer to its strength. For example, for a therapeutic study, Class I is a randomized controlled trial (RCT) blinded to outcome assessment or has objective outcomes; Class II is a flawed, RCT (nonconcealed) allocation; Class III is a nonrandomized, controlled study; and Class IV has no control group and nonmasked assessment of outcome; this is also referred to as expert opinion. Recommendations have 4 levels, A, B, C, and U, based on the level of evidence for each recommendation.[12]

Individual hospitals can produce evidence-based guidelines for patient care. TCH has an evidence-based outcomes center (EBOC) that produces these guidelines. For neurology, the EBOC has produced guidelines for seizures and status epilepticus (SE), traumatic brain injury (TBI), and stroke, and an autoimmune encephalitis protocol is in preparation.

The typical guideline is also educational, systematically reviewing the data, classifying the evidence, and including references. This article shall review selected guidelines, emphasizing those for inpatient care.

EVIDENCE-BASED PROTOCOLS

Status Epilepticus, Seizures, and Epilepsy

Seizures and SE: Many inpatients seen by our neurology teams have seizures or SE. Treatment guidelines were produced in 1993, by the American Epilepsy Society.[13] These guidelines established a timetable for treatment, recommending lorazepam, at 0.1 mg/kg, or diazepam, at 0.2 mg/kg, by 10 to 20 minutes. A practice parameter for the diagnostic assessment of SE was produced by the AAN/CNS in 2006.[14] The TCH EBOC produced a guideline for SE in 2009, which was updated in 2018.[15] Other national organizations have also developed guidelines for SE, especially the Neurocritical Care Society (NCS) in 2012,[16] and the American Epilepsy Society updated their treatment protocol in an evidence-based guideline in 2016.[17] Both these guidelines recommended the administration of lorazepam or diazepam at 5 minutes. The American Epilepsy Society (AES) reviewed the treatment of refractory convulsive SE in 2020.[18]

For the diagnosis of SE, the evidence shows that electrolytes were abnormal in 6%, blood cultures were abnormal in 2.5%, and a central nervous system infection occurred in 12.8% in those patients in whom these studies were done.[14] Antiepileptic drug (AED) levels were abnormal in 32%. It was observed that 3.6% had evidence of ingestion, 4.2% had inborn errors of metabolism, epileptiform abnormalities occurred in 43% of electroencephalographies (EEGs), and neuroimaging abnormalities occurred in 8% of scans (mostly computerized axial tomography [CAT] scan then). The recommendations were that blood cultures and lumbar puncture should be done when there is a clinical suspicion of a systemic or central nervous system infection (Level U), AED levels should be sent in children with epilepsy who develop SE, toxicology and metabolic studies should be considered when there is a clinical suspicion or when there is no identified cause, and EEG may be helpful in determining if there are focal or generalized features or if there is a concern for nonconvulsive SE or nonepileptic SE. Neuroimaging should be considered, after stabilization, if there are clinical indications or unknown cause. There is insufficient evidence to recommend routine neuroimaging.

Treatment of SE: The Epilepsy Foundation of America (EFA), the NCS, and the AES produced guidelines for the treatment of SE.[13,16,17] All these guidelines recommend a benzodiazepine as the first-line therapy for SE (**Table 1**). Lorazepam, midazolam, and diazepam are all used, and there is no evidence suggesting that one of these works better than the others. There has been an increasing use of intramuscular or intranasal midazolam, and intramuscular midazolam has been shown to be as effective as intravenous lorazepam. If there is no response to initial benzodiazepine therapy, then second-line medications are used. The AES guideline stated that there is no evidence suggesting the superiority of fosphenytoin, valproic acid, or levetiracetam over each other, but higher doses are recommended than may be typically used (see **Table 1**). Subsequently, the Established Status Epilepticus Treatment Trial showed equal efficacy among these 3 agents.[19]

For refractory SE, now defined as the failure of the initial benzodiazepine followed by a second-line medication, rather than a strict timeline, there is no data yet to suggest one treatment over the others.

Continuous EEG (CEEG) guidelines: The American Clinical Neurophysiology Society has produced 2 sets of guidelines, the first for CEEG monitoring in the newborn[20] and the second for CEEG monitoring in the older child and the adult.[21] These guidelines are important because they establish the conditions for which CEEG monitoring is needed. **Box 1** lists the neonatal indications, and **Box 2** lists indications in the older child.

Table 1
Evidence-based initial treatment of seizures and status epilepticus

First-line treatment, in-patient	IV lorazepam, 0.1 mg/kg, maximum 4 mg/dose, may repeat in 5 min, or IV diazepam, 0.2 mg/kg, maximum 10 mg/dose, may repeat in 5 min, or IV or IM midazolam, 0.2 mg/kg, maximum 10 mg/dose
Second-line treatment, if seizure continues	IV fosphenytoin, 20 mg PE/kg, maximum 1500 mg, or IV valproic acid, 40 mg/kg, maximum 3000 mg/dose, or IV levetiracetam, 60 mg/kg, maximum 4500 mg/dose
First-line treatment, outpatient	Rectal diazepam, 0.2–0.5 (age stratified); maximum dose 20 mg IN midazolam, 0.2 mg/kg

Abbreviations: IM, intramuscular; IN, intranasal; IV, intravenous; PE, fosphenytoin equivalent.
Data from Refs.[13,15–17,19]

CEEG monitoring: There is now the awareness that ongoing clinical and electrographic seizures may aggravate brain injury in the setting of an acute brain insult. The past use of EEG in the ICU was typically done using a short EEG, called a "routine" EEG, or a "snapshot" EEG. These shorter EEGs are less likely to detect actual electrographic seizures, because of the sampling error for a shorter versus a longer study. The introduction of digital technology has permitted longer monitoring times. In all ages, CEEG monitoring is recommended for disorders in which there is a high-risk of seizures. Given the overall relatively high incidence of electrographic seizures in the ICU, CEEG monitoring is preferred.

The guidelines for older children also list the reasons for performing CEEG: detect nonconvulsive seizures or nonconvulsive SE or characterize paroxysmal events in

Box 1
Conditions with a high risk of neonatal seizures that require continuous electroencephalographic monitoring

Acute neonatal encephalopathy: depression from perinatal asphyxia or after cardiopulmonary resuscitation

Cardiac or pulmonary insults with risk of brain injury: pulmonary hypertension, need for extracorporeal membrane oxygenation, critical congenital heart disease requiring early surgery with cardiopulmonary bypass

Infection: meningoencephalitis, sepsis

Trauma: intracranial, subarachnoid, subdural, or intraventricular hemorrhage or encephalopathy and suspicion for central nervous system injury

Inborn errors of metabolism, genetic syndrome involving the central nervous system

Stroke, cerebral sinovenous thrombosis

Premature infants with high-grade intraventricular hemorrhage, encephalopathy

Data from Schellhaas RA, Chang T, Tsuchida T, et al. The American Clinical Neurophysiology Society's guideline on continuous electroencephalographic monitoring in neonates. J Clin Neurophysiol 2011:1–7.

Box 2
Conditions associated with high-likelihood seizures on continuous electroencephalographic recording

Following convulsive SE, especially to detect nonconvulsive SE

Aneurysmal subarachnoid hemorrhage

Intraparenchymal hemorrhage

TBI: moderate to severe

Central nervous system infections

Recent neurosurgical procedures

Brain tumors

Acute ischemic stroke

Hypoxic-ischemic injury following cardiac or respiratory arrest, with or without therapeutic hypothermia

Sepsis-associated encephalopathy

Extracorporeal membrane oxygenation

Patients with epilepsy in the ICU: seizure exacerbation

Modified from Herman ST, Abend NS, Bleck TP, et al. Consensus statement on continuous EEG in critically ill adults and children, Part I: Indications. J Clin Neurophysiol 2015;32:87–95.

the ICU; assess the efficacy of therapy for seizures and SE; identify cerebral ischemia; monitor sedation and high-dose suppressant therapy; and assess the severity of encephalopathy and prognostication.[21]

EEG is also an indirect measurement of cerebral blood flow (CBF) and can be used to detect ischemia.[22] EEG frequencies decrease with a decrease in CBF. Early detection of a biomarker of deterioration can result in earlier intervention before an insult becomes irreversible.

The AAN, CNS, AES, and American Academy of Pediatrics (AAP) have produced multiple practice parameters for the care of the patient with epilepsy (**Box 3**).[23–32]

Sudden unexpected death in epilepsy (SUDEP) deserves specific mention because it has been controversial as to how much about SUDEP to discuss. The AAN and AES practice guideline recommends that the families of children with epilepsy should be informed that the rate is 1 of 5000 in children and 1 of 1000 in adults per year.[33] Seizure freedom is greatly associated with a decreased SUDEP risk.

Neuroimaging of seizures: There has been an initial report in 1996 and a reassessment in 2007.[34,35] Emergent neuroimaging is indicated when there is suspicion for a serious structural lesion; these are more likely when there is a new focal deficit; persistent altered mental status, with or without intoxication; fever; recent trauma; persistent headache; history of cancer; anticoagulation; or AIDS. An immediate CAT scan is indicated for patients with a seizure especially with an abnormal examination, predisposing condition, or focal seizure onset.

Neurocritical Care Guidelines

Neonatal neurology

Neuroimaging in the neonate: Head ultrasonography is useful in the management of the preterm infant (less than 3 week postmenstrual age [PMA]) and repeated between 36 and 40 weeks PMA to detect lesions such as intraventricular hemorrhage,

Box 3
Practice parameters for epilepsy

The first afebrile seizure[23]

Infantile spasms[24]

"Efficacy and Tolerability of the New Antiepileptic Drugs Part I: Treatment of New Onset Epilepsy"[25] and "Efficacy and Tolerability of the New Antiepileptic Drugs Part II: Treatment of Refractory Epilepsy"[26]

"Practice Guideline Update Summary: Efficacy and Tolerability of the New Antiepileptic Drugs Part I: Treatment of new Epilepsy"[27] and "Practice Guideline Update Summary: Efficacy and Tolerability of the New Antiepileptic Drugs Part II: Treatment-Resistant Epilepsy"[28]

Management of infantile seizures[29]

Febrile seizures: treatment of children with simple febrile seizures[30] and long-term treatment of the child with simple febrile seizure[31]

Neurodiagnostic evaluation of febrile seizures[32]

periventricular leukomalacia, and low-pressure ventriculomegaly, which affect prognosis. In encephalopathic term infants, CAT scan is useful to exclude hemorrhage and MRI can be performed after the first postnatal week to establish the pattern of injury and predict neurologic outcome.[36]

Therapeutic hypothermia (TH) for neonatal encephalopathy: TH is now established for the care of the term infant with asphyxia. A Cochrane review including 8 studies of 638 term infants with moderate and severe hypoxic-ischemic injury showed a decreased mortality and major neurodevelopmental disability by 18 months of age. There was an increased need for inotropic agents and thrombocytopenia.[37]

Acute stroke guidelines

Multiple guidelines exist for the management of acute stroke in children including recommendations from the American College of Chest Physicians in 2012,[38] Royal College of Pediatrics and Child Health in 2017,[39] Australian Childhood Stroke Advisory in 2018,[40] and the American Heart Association (AHA) in 2019.[41] The most recent update to the AHA guidelines includes 513 references and more than 60 recommendations for the management of cerebral venous sinus thrombosis, ischemic stroke, and intracerebral hemorrhage in both the neonatal and pediatric age groups. Discussion for each section includes presenting symptoms, risk factors, cause, management, evaluation, and outcome as well as recommendations for clinical practice and identification of knowledge gaps.[41]

In the current AHA guideline, care is mostly supportive for perinatal ischemic stroke. Hyperacute therapies have not been well studied in the neonatal population. Most often, anticoagulation and antithrombotic therapy are not required for secondary stroke prevention but may be considered if there is high risk of stroke recurrence such as thrombophilia or cardiac disease. MRI should be performed with magnetic resonance angiography of the head and neck with inclusion of magnetic resonance venography if there is concern for cerebral venous sinus thrombosis (CVST). For neonatal CVST, anticoagulation can be considered. There is variability among institutions in terms of the use of anticoagulation in this age group because of limited research in this population. If anticoagulation is not initiated, repeat MRI scan with venous imaging is warranted 5 to 7 days later to evaluate for increasing clot burden. For neonatal intracranial hemorrhage (ICH), vitamin K should be administered if there

is evidence for coagulation factor deficiencies. Per the AHA guideline, surgical intervention can be considered in the setting of elevated intracranial pressures (ICPs) or hydrocephalus related to hemorrhage. Seizures remain a common presenting symptom for acute stroke from all causes in neonates.

For children with strokes of all types, including ischemic, hemorrhagic, and CVST, the AHA guideline recommends they be treated in an institution with experience in managing childhood stroke including vascular neurology and neurocritical care expertise. The airway, breathing, and circulation should be stabilized, and appropriate supportive care is essential including adequate hydration, avoidance of fever, and maintenance of euglycemia. Close monitoring should occur for change in the examination or evidence of increased ICP. CEEG monitoring can be considered, particularly in patients with altered mental status or if there is a concern for nonconvulsive seizures. Seizures, when present, should be treated.

For acute ischemic stroke, the AHA guideline states that hyperacute stroke therapy remains controversial due to lack of randomized clinical trial data. The use of tissue plasminogen activator (tPA) and endovascular thrombectomy can be considered. This guideline suggests consideration for treatment in children with National Institutes of Health stroke scale (NIHSS) greater than or equal to 6 with radiographically confirmed larger artery occlusion and in larger children in whom the available catheters for acute intervention are appropriately sized. The guideline also recommends consultation and performance of the procedures by endovascular surgeons with experience in treating both children and adults with acute strokes. Special circumstances such as acute stroke in patients with sickle cell disease are also discussed in detail.

These guidelines have also addressed the use of hyperacute therapies in children with slightly modified inclusion criteria. Consideration may be given to use tPA in children aged greater than or equal to 2 years if the following criteria are met: pediatric NIHSS greater than or equal to 4 and less than or equal to 24, treatment can be initiated within 4.5 hours, and hemorrhage has been excluded on neuroimaging. The Royal College of Physicians also includes evidence of a partial or complete occlusion of the intracranial artery corresponding to the clinical or radiologic deficit. All guidelines make reference to evaluation for endovascular therapies for acute stroke in certain situations.

The AHA guidelines recommend consideration for hemicraniectomy if infarct volume is large, defined as at least half of the middle cerebral artery (MCA) territory. Prophylactic hemicraniectomy in the first 24 hours or serial imaging may be required to allow for early intervention. Early decompressive surgery should also be considered in acute cerebellar infarction. The guideline includes detailed recommendations for evaluation of the cause of stroke and secondary stroke prevention.

This latest AHA guideline also includes discussion on the management of hemorrhagic stroke in children. Patients should be stabilized, and coagulopathy, if present, should be corrected. Optimal blood pressure targets are unknown in the pediatric population. Care should be taken to avoid hypotension to maintain adequate cerebral perfusion pressure; however, uncontrolled hypertension can contribute to hematoma expansion and this should be avoided as well. Management of ICP and decompressive craniectomy may be required for posterior fossa or large lobar hemorrhages. Although it is recommended that seizures be treated, there is a lack of evidence to determine if prophylactic seizure medications should be started in pediatric patients with ICH. In adult patients with ICH, prophylactic phenytoin has been associated with higher morbidity and mortality, although studies have been conflicting. AHA guidelines for adult spontaneous ICH do not recommend prophylactic treatment of seizures.[42] Owing to the

higher risk of seizures in children and potential secondary brain injury from seizures and their complications, the AHA guideline for pediatric stroke states that prophylactic seizure medication can be considered, but this practice remains controversial. Vascular imaging should be obtained as part of workup for the cause. This guideline includes specific treatment recommendations for various causes including arteriovenous malformations, aneurysms, arteriovenous fistulae, and cavernous malformations.

Finally, management of CVST in pediatric patients is discussed for the first time in the AHA stroke guideline. Recommendations include supportive measures, monitoring for and management of increased ICP, and most often anticoagulation, although the guideline does not recommend using anticoagulation in the setting of otogenic lateral sinus thrombosis. If anticoagulation is not used, repeat venous imaging should be repeated in 3 to 7 days to monitor for extension of thrombus. Children should be evaluated for thrombophilia. Endovascular therapy with thrombolysis and thrombectomy can be considered in severe cases. Close monitoring for increased ICP should occur, as well as close monitoring of visual fields and fundoscopy. Carbonic anhydrase inhibitors, lumbar puncture, optic nerve sheath fenestrations, and ventriculo-peritoneal (VP) shunt may be required if vision is at risk and should be considered on a case-by-case basis with multidisciplinary input. Decompressive craniectomy has been reported in adult patients. Anemia, if present, should be corrected, and infection, if suspected, should be treated.

Pediatric traumatic brain injury

The Brain Trauma Foundation has produced guidelines for the management of severe TBI.[43] Severe TBI is defined as Glasgow Coma Scale score less than 9 in pediatric patients with the most recent update published in 2019 along with a consensus statement and guideline-based algorithm for first- and second-tier therapies. The guideline is divided into 3 major topics: monitoring, thresholds for treatment, and treatments with various subtopics in each category. Level of evidence was graded with each recommendation, and changes from previous editions of the guidelines were highlighted; included articles are summarized in table format. Discussion of the existing evidence is included for each recommendation made.

For neuromonitoring, an ICP monitor is suggested. As in previous editions of the guideline, advanced neuromonitoring including brain oxygenation is addressed; however, there is not enough evidence to support or refute its routine use. Initial neuroimaging should be obtained, but the guidelines neither recommend using computed tomographic (CT) scan alone as a means of determining whether a patient has increased ICP nor do they recommend routine serial neuroimaging studies such as CT.

Treatment thresholds for various parameters are defined in this guideline. For example, target ICP should be less than 20 mm Hg and cerebral perfusion pressure (CPP) targets should be between 40 and 50 mm Hg as to ensure maintaining a CPP >40 mm Hg. Despite no formal recommendation to use cerebral oxygenation monitors, the guideline recommends maintaining brain tissue oxygenation ($Pbt0_2$) greater than 10 mm Hg.

To achieve these thresholds, recommendations are made on using hyperosmolar therapy including hypertonic saline (HTS) and mannitol. For patients with intracranial hypertension 3% HTS is recommended, with bolus dosing of 2 to 5 mL/kg over 10 to 20 min and continuous infusion dosed at 0.1 to 1 mL/kg/h, using the minimum dose required to maintain ICP less than 20 mm Hg. For refractory ICP 23.4% HTS can be considered at the dose of 0.5 mL/kg to a maximum of 30 mL. For mannitol, no studies in children met inclusion criteria; however, the guideline recognizes that mannitol is commonly used for ICP management in children. Other measures to

control ICP include cerebral spinal fluid drainage via external ventricular device. Although the guideline recommends ensuring adequate sedation analgesia for patients in the ICU with TBI, it cautions against using bolus doses of fentanyl and midazolam for management of ICP because of risks of cerebral hypoperfusion associated with hypotension from these medications. The guideline also recommends against the use of hyperventilation less than 30 mm Hg to treat increased ICP. Normothermia should be targeted. Prophylactic hypothermia is not recommended; however, moderate hypothermia (32°C–34°C) for the management of intracranial hypertension can be considered. High-dose barbiturates and decompressive craniectomy can also be considered for refractory intracranial hypertension. Prophylactic seizure medication is recommended to reduce early posttraumatic seizures. Enteral nutrition within the first 72 hours is preferred.

Post–cardiac arrest management

The most recent pediatric cardiac arrest guidelines are from the AHA and were published 2019[44] and updated in 2020.[45] From a neurology standpoint, this is important as hypoxic-ischemic injury following cardiac arrest is a major determinant of overall outcome. These guidelines address optimal CPR and resuscitation technique, extracorporeal cardiopulmonary resuscitation, CEEG monitoring, and multimodal neurologic prognostication following cardiac arrest.

New in the 2020 guidelines is the recommendation for the use of targeted temperature management to either a goal of 32°C to 34°C followed by 36°C or actively targeting 36°C for 5 days. Regardless of the temperature target, fever must be avoided. CEEG monitoring is recommended. Although there is little randomized data to make a determination, treatment of clinical seizures and electrographic SE is suggested. These guidelines from 2019 and 2020 outline the current data informing post–cardiac arrest neuroprognostication.

The optimal timing to best prognosticate outcome in children is unknown. Adult guidelines suggest to wait at least 72 hours after the patient has been rewarmed to normal temperature and possibly longer. The pediatric guidelines identify a lack of evidence to support reliable evidence-based neuroprognostication in the first 24 to 48 hours postarrest in most cases. Care should be taken to assure that enough time has elapsed before prognostication. Using a multimodal approach is recommended. Ongoing neurologic evaluation is recommended for at least 1 year following cardiac arrest, and all patients should undergo rehabilitation evaluation.

Emergency neurologic life support

Emergency Neurologic Life Support (ENLS), created by the NCS, is a course composed of 14 evidence-based protocols in neurocritical care focusing on immediate care in the first hour of a neurologic emergency.[46] The course includes education on the acute stabilization of the neurocritical care patient as well as the management of specific disease processes including ischemic and hemorrhagic stroke, hypoxic-ischemic injury following cardiac arrest, traumatic injury of the brain and spinal cord, and SE. Participation is open to all health care professionals, and certification is awarded on completion of the course. Many neurocritical care units are requiring this training for their staff, including physicians, nurses, and pharmacists. We have offered ENLS certification to all neurology and critical care providers at our institution and are in the early stages of implementing this certification for the nurses in the pediatric neurocritical care unit. The focus of ENLS has been based on care for adult patients. However, each module includes a section with considerations for the pediatric patient, and this continues to expand with each iteration of the course.

Box 4
Outpatient practice parameters for pediatric neurology

"Practice Parameter, Evaluation of Children and Adolescents with Recurrent Headaches"[49]

"Pharmacologic Treatment of Migraine Headache in Children and Adolescents"[50]

"Practice Parameter: Diagnostic Assessment of the Child with Cerebral Palsy"[51]

"Practice parameter: Evaluation of the Child with Global Developmental Delay"[52]

"Evidence Report: Genetic and Metabolic Testing on Children with Global Developmental Delay"[53]

"Practice Parameter: Screening and Diagnosis of Autism"[54]

"Practice Parameter: Treatment for Insomnia and Disrupted Sleep Behavior in Children and Adolescents with Autism Spectrum Disorder"[55]

"Practice Parameter: Evaluation of the Child with Microcephaly (an Evidence-Based Review)"[56]

"Practice Parameter for the Assessment and Treatment of Children and Adolescents with Attention-Deficit/Hyperactivity Disorder"[57]

"Practice Parameter: Corticosteroid Treatment of Duchenne Dystrophy"[58]

Pediatric brain death

Guidelines for the determination of brain death in infants and children have been published with the most recent version in 2011.[47] The guideline outlines the procedure for determining brain death including prerequisites to testing, the clinical neurologic examination, the apnea test, and ancillary studies. The guideline has been endorsed by multiple professional societies including the AAN, AAP, CNS, Society for Critical Care Medicine, and World Federation of Pediatric Intensive and Critical Care Societies.

Recently, a multidisciplinary subcommittee of the AAN has drafted an updated consensus practice recommendations for the determination of pediatric and adult brain death or death by neurologic criteria. These recommendations are currently open for public comment with finalized recommendations to be published soon. In addition, guidelines for the determination of brain death/death by neurologic criteria were published as part of the World Brain Death Project as an effort to improve standardization in the approach to brain death internationally.[48]

There are other important practice parameters for children that are oriented toward the outpatient practice of child neurology (**Box 4**).[49–58]

CLINICS CARE POINTS

- Evidence-based medicine and clinical practice guidelines help standardize patient care.
- Evidence-based medicine is defined as the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. Evidence-based refers to applying the scientific method to acquire this data.
- Clinical practice guidelines are systematically developed based on medical evidence. Evidence-based practice using standard treatment protocols ensures the delivery of quality care across complex medical systems.
- Quality improvement is defined as the degree to which health care services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.

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