The Early Rehabilitation Results of Pediatric Patients with Refractory Epilepsy After Hemispherectomy

Dirençli Epilepsili Pediatrik Hastaların Hemisferektomi Sonrası Erken Rehabilitasyon Sonuçları

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ABSTRACT Objective: The aim of this study was to determine the early rehabilitation results after epilepsy surgery of patients who were followed because of epilepsy. **Material and Methods:** Nine patients who had intractable epilepsy and underwent epilepsy surgery were included in this study. Patients who were hemiparasis before the surgery were left with a residual hemiparesis after the hemispherectomy. The rehabilitation program was started as soon as the medical status of patients was stable after the surgery, and it was continued until the patients were discharged. The Canadian Neurological Scale, the Gross Motor Function Measure and Functional Independence Measurement for Child Patients (WeeFIM) were used for the assessment of the patients. The hemiparesis treatment program according to the neurophysiologic approach was performed for all patients. **Results:** The motor movement of the affected side of nine children increased after rehabilitation program, but only the improvement of leg was statistically significant (p< 0.05). Motor function improved [Gross Motor Function Measure: baseline 36.41(Range 91.92); after rehabilitation 46.82 (Range 78.74) p< 0.05]. Functional skills increased and caregiver assistance lessened. **Conclusion:** Although hemispherectomy often controls the seizures, patients are left with a residual hemiparesis. This situation reveals the necessity of rehabilitation for these patients. The results of this study have shown that the early rehabilitation program was useful to improve the functions of epileptic patients after surgery. Follow-up studies of larger samples of children who are followed over longer time spans will be needed to confirm these results.

Key Words: Epilepsy; hemispherectomy; motor activity; pediatrics; recovery of function; rehabilitation

ÖZET Amaç: Çalışmanın amacı, epilepsi nedeni ile takip edilen hastaların epilepsi cerrahisi sonrası erken rehabilitasyon sonuçlarını belirlemekti. **Gereç ve Yöntemler:** Çalışmaya dirençli epilepsiye sahip olan ve cerrahiye giden 9 hasta dâhil edildi. Cerrahi öncesi hemiparaziye sahip olan hastaların hemisferektomi sonrası hemiparazileri devam etmiştir. Rehabilitasyon programına cerrahi sonrası hastaların tıbbi durumları stabil olur olmaz başlanıldı ve hastalar taburcu olana kadar devam edildi. Hastaların değerlendirilmesinde Kanada nörolojik skalası, Gross Motor Fonksiyon Ölçümü ve fonksiyonel bağımsızlık ölçeği (WeeFIM) kullanıldı. Tüm olgulara nörofizyolojik yaklaşımlara göre düzenlenen hemiparazi tedavi programı uygulandı. **Bulgular:** Rehabilitasyon programı sonrasında 9 çocuğun etkilenmiş taraf motor hareketleri artmıştır. Fakat sadece bacak hareketlerindeki gelişme istatiktiksel olarak anlamlıdır. Motor fonksiyonlar gelişmiştir. [Gross Motor Fonksiyon: başlangıç 36.41(Range 91.92); rehabilitasyon sonrası 46.82 (Range 78.74) p< 0.05]. Fonksiyonel beceriler artmış ve yardım miktarı azalmıştır. **Sonuç:** Hemisferektomi sık sık nöbetleri kontrol etmesine rağmen hastalarda hemiparazi kalabilmektedir. Bu durum rehabilitasyonun gerekliliğini açığa çıkarmaktadır. Çalışmamızın sonuçları, cerrahi sonrası epileptik hastaların fonksiyonlarını geliştirmede rehabilitasyon programının yararlı olduğunu göstermiştir. Bu sonuçların doğrulanması için daha fazla hasta üzerinde ve uzun takipleri içeren çalışmalara ihtiyaç olacaktır.

Anahtar Kelimeler: Epilepsi; hemisferektomi; motor aktivite; pediatri; fonksiyonun geri kazanılması; rehabilitasyon

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Hemispherectomy refers to a variety of operations that functionally isolate the olcerebral cortex of one hemisphere from the rest of the nervous system.[1] Patients with major or diffuse hemispheric injury and intractable seizures are usually considered for surgery during childhood. They suffer from a wide variety of conditions, which may be divided into three groups based on the mode of onset of the disease and tempo of its progression. The first group consists of patients with a sudden, massive insult that results in fixed neurologic deficit. These are usually children with infantile hemiplegia, but those with posttraumatic brain injury or vascular insults of various etiologies may also be included. The second group is made of patients with congenital conditions such as Sturge-Weber syndrome or neuronal migrational disorders such as hemimegalencephaly, whose neurologic manifestations often have a later onset and may be progressive. The final group consists of disease with a delayed presentation and progressive course, such as Rasmussen encephalitis.[2]

Early surgery offers the advantages of seizure reduction while maximizing the compensatory abilities of the immature nervous system. Both research and case reports indicate that hemispherectomy can be an effective intervention for seizure control. About 80% of the patients have approximately 80% reduction in the frequency of their seizures after hemispherectomy.[3-5] Decrease of the seizure frequency and severity widens the scope of motor and social functioning. In literature, t[13] J.A. Gonzalez-Martinez, A. Gupta and P. Kotagal *et al.*, Hemispherectomy for catastrophic epilepsy in infants, *Epilepsia* (2005), pp. 1518-1525. View Record in Scopus | Cited By in Scopus (22)tttThe sensorimotor recoveries after cerebral hemispherectomy have been well documented.[6,7] In 1999, Battaglia D and others performed a long-term follow-up of 10 patients with hemimegalencephaly and refractory epilepsy, after having treated them with hemispherectomy. They concluded the neurological deficit did not increase after the surgery, and the quality of life improved significantly.[6] On the other hand, Van Empelen R and others examined impairments, activities and social participation in 12 children (mean age at surgery 5.9 years) who were investigated before and three times over a 2-year period after hemispherectomy. They reported that range of motion was abnormal prior to the operation and remained so after the operation. Motor function increase was 20% after 2 years.[7] However, no study has attempted to show whether the acute rehabilitation intervention can improve motor functions following the surgery. To maximize compensation of the neuronal mechanism together with the possible benefits of the early operation must weigh the rehabilitation interventions after the surgery. None of the literature has described the postoperative early physical therapy management for this patient population.

This study addressed the questions to what degree motor impairments, motor functions and aspects of activities daily of living exist after rehabilitation.

MATERIAL AND METHODS

PATIENTS

Between 1996 and 2008, 9 children (four girls, five boys), all of whom had been referred to the Hacettepe University Hospital, underwent functional hemispherectomy. Exclusion criterions were being age older than 18 years at the time of the surgery, the presence of tumours, and metabolic disease. The pathology had been ascertained both by imaging and pathological examination of the surgical specimen. Six of the nine had encephalopathy; the aetiologies were Rasmussen encephalitis (n: 4), meningitis (n: 1), brain injury (n: 1). One child had Sturge Weber Syndrome and, the remaining two children had cortical dysplasia. The characteristics of the patients and type of the surgery techniques were shown in Table 1. Five children underwent a right-sided and four children a left-sided hemispherectomy. Median age at the surgery was 10.46 ± 4.08 After the surgery patients were left with a residual hemiparesis. All patients attended a rehabilitation programme after hemispherectomy. The parent(s) of the children and, if over 12 years of

TABLE 1: The characteristics of patients and rehabilitation duration (days).

No	Sex	Age(years) (at seizure onset)	Age (years) (surgery)	Type of operation	Aetiology	Rehabilitation Duration (days)
1	M	6	11	Right frontotemporal lobectomy	Brain injury	3
2	F	4	8	Rigth frontotemporal lobectomy	Meningitis	12
3	F	0.5	9	Left temporal+frontal+oksipital lobectomy	Cortical Dysplasia	14
4	M	11	13	Left frontal lobectomy	Cortical Dysplasia	21
5	F	5	6	Rigth hemipherectomy	Rasmussen encephalitis	7
6	M	7	14	Left hemipherectomy	Rasmussen encephalitis	14
7	M	4	9	Rgth hemipherectomy	Rasmussen encephalitis	63
8	F	0.5	3	Left hemipherectomy	Sturge weber	54
9	M	8	10	Rigth hemipherectomy	Rasmussen encephalitis	15
Total X ± SD	5M+4F	5.11 ± 3.40	9.22 ± 3.38			22.56 ± 21.11

F: Female; M: Male; SD: Standart deviation.

age, the children themselves, gave informed written consent for participation in the study.

INSTRUMENTS

Patients were assessed in the neurosurgery department of the Hacettepe University Hospital with a standard protocol before and after the rehabilitation programme. Functional status was assessed using the WeeFIM (The Functional Independence Measure for Children). Gross motor function was evaluated by the GMFM-88 (Gross Motor Function Measure-88). Canadian Neurological Scale was used for the neurological assessment of patients.

MOTOR IMPAIRMENT: CANADIAN NEUROLOGICAL SCALE (CNS)

To assess motor impairment, we used the Canadian Neurological Scale.[8,9] The Canadian Neurological Scale was designed as a simple clinical tool for evaluating and monitoring the neurologic status of acute hemiparesis or hemiplegia patients. This scale includes two sections (mentation and motor function). We only tested the motor function in leg and arm. This section are scored on four-point (0: Total paralysis, absence of motion or contraction of muscle without joint movement, 0.5: Significant, cannot completely overcome gravity in range of motion, 1: Mild, able to move against gravity but incomplete resistance to force, 1.5: None). The total score are calculated and higher score mean better motor function.

EVALUATION OF ACTIVITIES OF DAILY LIFE (ADL): THE FUNCTIONAL INDEPENDENCE MEASURE

The Functional Independence Measure for Children (WeeFIM) is a simple-to-administer scale for assessing functional independence across 3 domains (self-care, mobility, cognition) in children. The WeeFIM is a validated and reliable tool and designed as an evaluative measure that operationally defines tasks pertinent to a child's independence across different settings. It measures usual performance to criterion standards and includes 18 items across 3 subscales (self-care, mobility, cognition) for children with developmental disabilities. The child's performance on each item is scored on a 7 point level ordinal scale, one indicating complete dependence and 7 signifying complete independence. The total score is calculated from the scores obtained for the three subscales.[10-13]

MOTOR CAPACITY IN CHILDREN: THE GROSS MOTOR FUNCTION MEASURE

The Gross Motor Function Measure (GMFM-88) is a standardized clinical observational instrument designed to evaluate change in gross motor activities in children with cerebral palsy. It assesses how much of an activity a child can accomplish, rather than how well the activity is performed. The GMFM-88 consists of 88-264 items grouped into five dimensions: lying and rolling (17 items 51); sitting (20 items 60); crawling and kneeling (14 items 42); standing (13 items 39); and walking, running and jumping (24 items 72). The items are scored on four-point ordinal scales [0 = cannot initiate, 1 = initiates, but completes less than 10%, 2 = partially completes item (11-99%), 3 = completes item independently]. Good reliability using the intraclass correlation coefficient has been reported; the values varied from 0.87 to 0.99. Percentage scores for each of the five GMFM dimensions and a total GMFM percentage score are calculated. Higher scores mean better performance.[14]

REHABILITATION PROGRAM

Rehabilitation programme was started when medical conditions of the patients were stable immediately following epilepsy surgery at the hospital and continued until patients were discharged (median 19.19 ± 20.32 days). The Bobath neurodevelopmental therapy (NDT) approach which is the most common physiotherapy approach was used in children with hemiparasis. NDT approach focuses on sensory motor components of muscle tone, reflexes and abnormal movement patterns, postural control, sensation, perception, and memory. Also, the main aim of NDT is to change the neural-based motor responses of the central nervous system. The concept encompasses three main principles including facilitation, stimulation,and communication in order to provide normal movement experience, minimize motor-sensory disorders, and improve functional independence levels of children.[15] The Bobath concept was performed by an experienced physiotherapist (S.B) that had 10 years of experience in the paediatric rehabilitation field. Exercises were done for at least 30 minutes, 5 days a week.

Passive stretching: It was a manual application for spastic muscles to relieve soft tissue tightness. Manual stretching may increase range of movements, reduce spasticity, or improve walking efficiency in children with spasticity.

Static weight-bearing exercises. They were used in order to stimulate antigravity muscle strength, improve bone mineral density, improve self-confidence, reduce spasticity, and improve fine motor function.

Muscle strengthening exercises. It aimed to increase the power of weak antagonist muscles and of the corresponding spastic agonists and to provide the functional benefits of strengthening in children.

Functional exercises. Walking and climbing stairs training improve aerobic capacity, physical fitness, the intensity of activities, and quality of life.

Electrical stimulation. It is a useful modality due to the lack of selective muscle control required for specific strengthening programs. In particular, neuromuscular and threshold electrical stimulation was used for strengthening the quadriceps muscles in children with hemiparasis.

Data analysis

Non parametric tests were used as the group was small and data could not be proved to be normally distributed. All differences before and after training were analyzed with the Wilcoxon signed rank test. Significance level was set at $p<0.05$.

RESULTS

MOTOR IMPAIRMENTS

At the pre-rehabilitation baseline, the motor movement of the extremities on the affected side was mildly to moderately impaired. After rehabilitation, the affected leg had recovered ($p < 0.05$). In the arm, proximal and distal motor movement recovered, although this was not statistically significant. (Table 2).

GMFM-88

The GMFM administered to the nine children showed statistically significant change at follow-up as-

TABLE 2: The results of the Canadian neurological scale of patients.

	Pre-treatment Median(range)	Post-treatment- Median(range)	P value
Arm proximal	3.00(6.00)	3.50(4.00)	0.066
Arm distal	0.50(5.50)	1.00(5.50)	0.317
Leg proximal	4.50(3.00)	5.00(2.00)	0.023*
Leg distal	1.00(3.00)	2.00(2.50)	0.039*
Total	8.50(15.50)	9.50(13.00)	0.012*

*p< 0.05.

sessment when compared with the previous assessment (*p*<0.05). The change between pre- rehabilitation and post-rehabilitation data was statistically significant ($p < 0.05$) in all domains of activity (Table 3).

ADL: THE FUNCTIONAL INDEPENDENCE MEASURE FOR CHILDREN (WEEFIM):

The change between pre-rehabilitation and post-rehabilitation data was statistically significant ($p < 0.05$) in all domains of functional skill except of the cognition domain (Table 4).

DISCUSSION

Cerebral hemispherectomy is an increasingly used surgical procedure to treat therapy-resistant epilepsy.[16] Hemispherectomy often controls seizures, but patients are left with a residual hemiparesis. Although most children after hemispherectomy eventually learn to walk, they display hip circumduction and other gait deviations to advance and clear the affected foot. In this term, to maximize compensation of the neuronal mechanism together with the possible benefits of early operation must weigh the rehabilitation interventions.[17] In this study has analyzed the outcomes of 9 children who attended the rehabilitation program after hemispherectomy at the neurosurgery department. After the surgery children were seizure-free and all children had shown improvement at the end of rehabilitation training.

TABLE 3: The results of the gross motor function measure (GMFM-88) scores of patients.

GMFM (%)	Pre-treatment Median(range)	Post-treatment Median (range)	P value
Lying. rolling	80.39(82.35)	90.20(49.02)	0.012*
Sitting	68.33(100.00)	78.33(61.67)	0.018*
Crawling. kneeling	33.33(100.00)	47.62(100.00)	0.028*
Standing	7.69(89.74)	17.95(92.31)	0.008*
Walking. running. jumping	0(87.50)	0 (95.83)	0.465
Total score	36.41(91.92)	46.82(78.74)	0.008*

*p<0.05.

TABLE 4: The results of the functional independence measure for children (WeeFIM) scores of patients.

WeeFIM	Pre-treatment Median (range)	Post-treatment Median(range)	P value
Self Care	29(41)	38(32)	0.018*
Mobility	14(30)	20(21)	0.018*
Cognitive	35(19)	35(10)	0.180
Total score	78(78)	89(60)	0.012*

*p<0.05.

MOTOR OUTCOME

In our study, the arm ability of all patients is more impaired than the leg before rehabilitation. After hemispherectomy the difference in course and degree of impairment between the upper and lower limbs can be explained by several hypotheses. The upper limb, particularly the hand, has become specialized to perform skilled hand movements and is more under the control of the corticospinal pathways than the leg, while the locomotor task of the lower limbs is more under the control of the spinal neuronal circuits. This could be a reason why the arm is more impaired than the leg after hemispherectomy. It was suggested that the lumbosacral spinal cord contributes to the ability to walk in animals and humans.[18,19] There is some indirect evidence that the locomotion depends upon neuronal circuits (networks of interneurons) within the spinal cord which are thought to be a type of central pattern generator. Another explanation may be the following: preservation of the ability to ambulate may be due to contributions of subcortical regions of the nervous system. Several structures in the nervous system other than the cortex are known to support coordinated movement; these include the cerebellum and the mesencephalic locomotor region of the brain stem, structures which are preserved after hemispherectomy. Thirdly, intact ipsilateral cortical pathways could be responsible for preserved locomotion. Wieser and his colleagues described the transfer of motor control of the left leg to the ipsilateral primary motor cortex in a patient with a right-sided surgical resection. He reasoned that both motor areas have the latent capacity to control motoricity bilaterally and that the ipsilateral capacity is brought into function only after removal of the opposite hemisphere. This line of reasoning does not, however, account for the fact that, apparently, transfer of motor control of the arm is less successful than that of the leg.[20] In our study the motor function of our patients recovered on hemiparesis side after rehabilitation program, but the improvement of proximal and distal motor function of the affected leg were more than upper extremity due to the above-mentioned reasons. Similary to our study, Van Empelen R and others reported impairments in 12 children (mean age at surgery 5.9 years) who were investigated before and three times over a 2-year period after hemispherectomy. All patients attended a rehabilitation programme at a regional rehabilitation centre after hemispherectomy. At the presurgical baseline, the muscle strength of the extremities on the affected side was mildly to moderately impaired. Six months after hemispherectomy, scores reflected a further postsurgical significant decrease in the arm and a non-significant decrease in the leg. Two years after surgery, the affected leg had recovered to presurgery strength. In the arm, strength remained very poor distally, whereas proximal strength recovered, although this was not statistically significant. They showed that the motor function of children increase was 20% after 2 years. But there were no reports whether the children attended the rehabilitation programme .[21]

Afterward, Van Empelen R and others examined whether severity of epilepsy, motor functioning, and epilepsy-related restrictions change in children with medically intractable epilepsy who are ineligible for epilepsy surgery. The study was a prospective, longitudinal, 2-year follow-up of 28 children. They reported that muscle strength, range of motion, and muscle tone did not change significantly during follow-up. But in this study there were no reports whether 28 children attended the rehabilitation programme.[22]

In addition the rehabilitation duration can be the other reason for this result. All patients were treated until discharged and then, they were referred for admission to another rehabilitation unit. Therefore, patients were treated only for 19.19 ± 20.32 days. Eventually, the upper extremity improvement was less than lower extremity improvement for a shorter period of time. While motor control of the lower extremity can be improved through gross motor activities like standing, walking, etc, the fine motor coordination activities is basis for the upper extremity function. We know that fine motor skills typically develop after gross motor skills. Therefore, this short rehabilitation duration could not enough for upper extremities improvement.

GMFM

To our knowledge, this is the first study comparing motor activity in children who had epilepsy surgery after acute rehabilitation programme with reference GMFM-88 scores as described in the GMFM manual by Russell and colleagues[14]. The results of GMFM seem to be useful when determining whether the child is performing in accordance with her/his expected growth curve of gross motor development. At least after the surgery the results can help to predict motor development in children. We assessed the GMFM after rehabilitation, and found changes in scores in all children. Our data suggests that the motor activity increases in children who has joined the rehabilitation after the epilepsy surgery. This finding is important, considering the uncertainties of parents and children about motor function after the surgery.

There are only a few studies that have examined the GMFM in children who underwent epilepsy surgery.[21-23] The aim of these studies was to examine whether severity of epilepsy, motor functioning, and epilepsy-related restrictions change after surgery in children with medically intractable epilepsy. All children were investigated before and three times over a 2-year period after hemispherectomy and it was found that the functional motor abilities of children increased after the surgery. However in only one study, researchers indicated that all patients attended a rehabilitation programme at a regional rehabilitation centre after hemispherectomy.

ADL

In our study, we calculated both a total score and domain subscores in self-care, mobility, and cognition. All WeeFIM domains except cognitive increased. All patients had a better cognitive performance status before rehabilitation. The scores of cognitive status of all patients before rehabilitation was 86% of the normal value and so cognitive status not showed more improvement in a short period of time. In our study, in children the scores for functional skills on the WeeFIM increased from before rehabilitation: 78 to 89, after rehabilitation, indicating a clinically relevant improvement. Similary to our study, Van Empelen R and others examined the activities daily of living by The Pediatric Evaluation of Disability Inventory (PEDI) in children with medically intractable epilepsy who are ineligible for epilepsy surgery and they reported the children need less assistance with self-care, mobility and social functioning over a 2-year period after hemispherectomy.[21,22]

Also systematic reporting of type and quantity of rehabilitation programme with functional assessments before and after rehabilitation would allow researchers to track functional changes as in our study.

REHABILITATION TIME

Rehabilitation duration is very important after the epilepsy surgery. To achieve independence, all the patients need to take long time rehabilitation. In our study, the duration of the rehabilitation programme was not longer because all patients were discharged from the hospital once they became stabile. Therefore in our study, the desired results exactly could not be reached.

In literature, there are few evidences to support short-term rehabilitation interventions that were applied to children who underwent epilepsy surgery. de Bode S and colleagues examined whether locomotor training, which included body weight-supported treadmill therapy, improved walking after cerebral hemispherectomy. Hemispherectomy patients (n = 12) underwent 2 weeks of gait training for at least 30 hours each. They found locomotor training of hemispherectomy patients improved mobility and reported that these findings supported the notion that hemispherectomy patients may respond to rehabilitation interventions through mechanisms of activity-dependent cortical plasticity.[24] Then de Bode S and colleagues described the feasibility and efficacy of the use of constraint-induced movement therapy (CIMT) in 4 individuals (aged 12-22 years) who underwent cerebral hemispherectomy (age at time of surgery= 4-10 years). The patients received a shortened version of CIMT for 3 hours each day for a period of 10 days. In addition, a standard resting splint was used for the unimpaired hand for an 11-day period. The findings suggested that CIMT may be a feasible method of rehabilitation in individuals with chronic hemiparesis, possibly leading to neuroplastic therapy-related changes in the brain. [25]

Researchers evaluated more the functional results of children who underwent epilepsy surgery. Tan Q and others retrospectively analyzed their experience to evaluate the seizure control and complications of this surgical technique in 8 cases of intractable seizures whom functional hemispherectomy was performed. All the patients were followed up for 3-11 years (mean 6.7 years). Satisfactory seizure control was obtained in all the cases. Life quality improved and patients worked or studied well after the operations.[23] In 2007, Terra-Bustamante VC and others analyzed outcome of hemispheric surgeries for refractory epilepsy in 39 pediatric patients. Most frequent etiologies were Rasmussen encephalitis (30.8%) and malformation of cortical development (23.1%). Postsurgical outcomes were Engel classes I and II for 61.5% of the patients. In general, 89.5% of the patients exhibited at least a 90% reduction in seizure frequency. All patients had acute worsening of hemiparesis after surgery. They showed that a marked reduction in seizure frequency may be achieved, with acceptable neurological impairments.[26]

But there were no reports about the effects of short- and long-term rehabilitation programme or whether the children attended the rehabilitation programme.

We think that our study shed light on rehabilitation studies about epilepsy surgery in the future. Because early surgery in childhood may take advantage of the child's brain plasticity and enhance the chances of recovery from seizure related damage and from possible postsurgical neurologic deficits.[27-29] The perinatal infarct group demonstrated greater activity in the cingulate cortex, whereas the Rasmussen's encephalitis group had significant activations in the insula, suggesting etiology-specific differences in reorganization. These findings are discussed in the framework of our understanding of mechanisms of cortical plasticity in the injured brain and its relevance to neurologic rehabilitation. Rehabilitation strategies, should target cortical plasticity and promote successful representational competition of neurons with direct and indirect inputs to the affected side's spinal motor pools from the remaining cortex. It is known that task-specific treatment often leads to better performance and cortical representational plasticity by a growth-related mechanism, such as increasing numbers of dendritic spines, axonal and dendritic branching, and synaptogenesis. It was suggested that children who undergo hemispherectomy and currently do not routinely receive rehabilitation to improve gait and use of the upper and lower extremities should receive task-specific training to enhance brain reorganization following hemispherectomy.[17]

Epilepsy is an evolutionary disease process that changes with the maturation of the central nervous system. The rehabilitative model provides the framework for a dynamic treatment plan to meet the changing needs of the child with epilepsy through the social and developmental changes of childhood and adolescence. The development of epilepsy may complicate the recovery from many acute and chronic conditions that affect the central nervous system. The rehabilitation process must address these many of these aspects of the disease process and its sequelae, including epilepsy. This makes neurologists uniquely qualified to manage the rehabilitation team.[30]

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