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Original Article

Costs and Clinical Outcomes of Epilepsy Surgery in Children With Drug-Resistant Epilepsy

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ABSTRACT

PURPOSE: Approximately 20% of children with epilepsy are drug-resistant, incurring considerable costs. Epilepsy surgery has been shown to be an effective intervention in this population. This study provides an initial look at the costs associated with surgical management of children with drug-resistant epilepsy as compared with medical management alone. **PROCEDURES:** In a retrospective cohort study of children with drug-resistant epilepsy referred for possible surgical intervention, we compared direct costs of those treated surgically versus those offered surgery but managed medically instead. We also assessed the difference in seizure frequency between the two groups. **FINDINGS:** There were 94 total patients, 78 (83%) in the surgical group and 16 (17%) in the medical group. The median (25th-75th percentile) cost of the epilepsy surgery hospitalization was $118,400 ($101,900-$143,800). Total median annual follow-up costs, not including the cost of surgical hospitalization, were not significantly different between the two groups at 1- or 2-year follow-up. However, the surgical patients who were seizure-free at 1-year follow-up, and those that remained seizure-free at 2-year follow-up, had significantly lower costs compared with the medical group ($8000 versus $16,200, $P = 0.04$ and $4300 versus $7600, $P = 0.05$, respectively). The surgical group had significantly fewer seizures compared with the medical group at 1-year follow-up. **CONCLUSIONS:** Although epilepsy surgery is expensive and the overall costs of surgical and medical management are similar in the first 2 years, patients who achieved seizure freedom after surgery had lower costs compared with those treated medically.

Keywords: intractable epilepsy, epilepsy surgery, pediatric, economic

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Introduction

Epilepsy in children has an incidence of approximately 45 per 100,000 children per year,[1,2] with the greatest incidence in the first year of life. Estimates show that about 20% of children with epilepsy will have drug-resistant epilepsy—defined by the International League Against Epilepsy (ILAE) as failure of adequate trials of two tolerated and appropriately chosen antiepileptic drugs (AEDs), whether as monotherapy or in combination.[3,4]

The economic burden of epilepsy is greatest in individuals with drug-resistant epilepsy. One analysis found that the 20% to 25% of children and adults with epilepsy who did not respond to medical therapy accounted for approximately 38% of annual direct and 86% of indirect medical costs of epilepsy.[5] Review of claims for pre- and postemergency department (ED) visits for loss of seizure control in one study showed a greater than three-fold annual increase in epilepsy-related expenditures.[6] The few existing pediatric studies have corroborated a higher cost of drug-resistant epilepsy compared with well-controlled epilepsy.[7-12]

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An alternative to medical management is epilepsy surgery, resulting in seizure remission in 45% to 80% of patients.[13-24] Epilepsy surgery in the appropriate candidate can prevent debilitating seizures, improve quality of life, and potentially reduce long-term costs; however, the magnitude of these changes is not known. The published studies that note higher graduation rates, higher employment rates, and higher scores on quality-of-life scales are largely in adults or combine adult and pediatric data.[23,25]

Lack of such data specific to the pediatric population is a major obstacle in determining best practices. One Canadian group found that costs over a 25-year period were 8% greater in medically managed children with epilepsy compared with surgically managed children, but the savings were not realized until approximately 14 years postoperation.[26] A more recent Canadian study found that epilepsy surgery in children was more cost-effective and more successful at reducing seizure frequency compared with medical management.[27] Although those data are informative, the medical systems and associated costs of epilepsy care differ substantially between Canada and the United States. Hospital costs in the United States have been found to be up to 24% higher when compared with similar treatments in Canada because of differences in administration, labor, and supply costs.[28]

Although epilepsy surgery is expensive, few data exist on the potential long-term cost-savings of surgical management versus medical management in children. We sought to determine direct healthcare costs in a sample of US children referred for evaluation of surgical management of drug-resistant epilepsy, comparing the costs of care for those who were managed surgically versus those who, although eligible for surgery, chose to continue to be managed medically. We also compared seizure frequency among the surgically versus medically managed children.

Methods

Study design

We conducted a retrospective cohort study of all patients who underwent epilepsy surgery evaluations (i.e., phase 1 evaluation) at the epilepsy surgery clinic of Cincinnati Children's Hospital Medical Center (CCHMC) between 2008 and 2010. Data were collected from the time of epilepsy surgery eligibility determination through 2011. This study was approved by the Institutional Review Board at CCHMC.

Patient identification

Patients who were referred to the epilepsy surgery clinic, or admitted to CCHMC for inpatient epilepsy surgery evaluation, were identified by using the epilepsy surgery clinical database and/or medical chart review. Patients included were 0 to 21 years old; had drug-resistant epilepsy; and were deemed to be a surgical candidate based on the results of the phase 1 evaluation (which included video electroencephalography monitoring, brain magnetic resonance imaging, and, for most patients, ictal and interictal single-photon emission computed tomography, magnetoencephalography, and positron emission tomography scans). Patients were excluded if they had a history of prior epilepsy surgery or were deemed not to be a candidate for epilepsy surgery. For the analysis, patients in the surgical group were those who were evaluated, deemed to be a surgical candidate, and had undergone surgery during the study period. Surgical interventions included resective surgery (focal or hemispherectomy), corpus callosotomy, or placement of a vagus nerve stimulator. Patients in the medical group were those that were evaluated, deemed to be a surgical candidate, but chose not to undergo surgery, instead continuing with pharmacologic or dietary management of seizures.

Patient records

Each patient's medical record, either in paper or electronic form, was reviewed, with the following variables extracted: demographics (age, race/ethnicity, sex); seizure frequency and characteristics (age of seizure onset, type of seizures, etiology of seizures, duration of epilepsy); and AEDs (prior medications, current medications, and length of time taking each medication).

Costs

We derived the direct costs associated with this patient sample by using the institution's cost accounting system. Costs were determined for medications; outpatient care related to epilepsy, but not part of the presurgical (phase 1) evaluation (neurology clinic visits, neurosurgery clinic visits, epilepsy-related ED visits, routine laboratory studies, electroencephalograph testing, neuroimaging); inpatient care from the time of inclusion in the study (acute hospitalizations for seizure-related diagnoses); and inpatient surgical care (procedure type, length of stay, laboratory testing, therapies, medications, imaging, surgical costs, room/board cost). We calculated annual postoperation costs for those that underwent epilepsy surgery (surgical group), and annual costs from the date of decision of epilepsy surgery eligibility for those who decided to continue medical management (medical group). Costs of the initial surgical eligibility evaluation (phase 1) were not included.

Costs incurred within our institution were derived from charges using the institutional cost-to-charge ratio. Costs incurred outside of our facility, such as ED visits at other hospitals, diagnostic studies performed at other laboratories, or AEDs that were captured in the CCHMC medical record were calculated using cost estimates and Medicare-based cost accounting methodology. With regards to medication costs, because our institution serves both the local community and patients from all regions of the country, it was not possible to obtain medication cost data from every pharmacy used. Therefore, we used the average cost of standard doses of each AED from the Red Book.[29] All costs were adjusted to 2012 costs based on Consumer Price Indices from the Centers for Medicare & Medicaid Services.

Data collection

In this study, we collected data beginning after the date of the epilepsy surgery team conference at which it was determined that a patient was a surgical candidate. For patients in the surgical group, data were analyzed in annual increments through 2011. There was an average delay of 3 months between the surgical evaluation conference date and the date of admission for the operation due to the need for scheduling, obtaining insurance preauthorization, etc. For patients in the medical group, data were analyzed from the date after the decision of surgical eligibility in annual increments through 2011. Any patient in the medical group who went on to have surgery remained in the medical group for statistical analyses.

Statistical analysis

Categorical variables were described using frequencies and percentages. Continuous demographic variables were described using means and standard deviation. Because of skewness, the cost variables were reported as medians with 25th and 75th percentiles. Fisher's exact test was used for categorical data. We used the Wilcoxon signed-rank test to evaluate group differences for continuous data. All analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC). The P values were considered significant at an $\alpha < 0.05$.