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The direct cost of epilepsy in children: Evidence from the Medical Expenditure Panel Survey, 2003–2014

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ABSTRACT

Introduction: Epilepsy is frequent in children and often requires complex healthcare interventions. There is a paucity of recent and detailed healthcare expenditures among children with epilepsy in the United States (US).
Methods: Data on children (aged ≤17 years) from the Medical Expenditure Panel Survey-Household Component (MEPS-HC) from 2003 to 2014 were analyzed. Unadjusted overall and specific cost components were compared between children with epilepsy and those without epilepsy. We used a two-part model with gamma distribution and log link for the estimation of independent incremental cost incurred by epilepsy in children. Unadjusted and adjusted mean expenditures and aggregate burden of epilepsy were estimated.
Results: Out of 54,393,387 (weighted) US children, 457,873 (0.84%) had epilepsy. Children with epilepsy had nearly six times higher healthcare expenditure than those without epilepsy ($2024 [95% confidence interval (CI): 1917–2130] vs. $12,577 [95% CI: 7922–17,231]). Unadjusted inpatient expenditure for epilepsy ($4418 [95% CI: 1550–7285) was ten times higher than that for children without epilepsy, representing more than one-third of unadjusted total direct cost. The adjusted difference in medical expenditure between children with and those without epilepsy was $8317 (95% CI: 3701–13,363). The annual unadjusted aggregate cost of epilepsy in children was approximately $5.8 billion. The annual adjusted difference in cost of epilepsy between children with and those without epilepsy was $3.8 billion.
Conclusion: Unadjusted and adjusted medical expenditure among children with epilepsy is high. The high expenditure is essentially driven not only by inpatient expenditure but also by home healthcare, outpatient, and medication healthcare expenditures.

1. Introduction

The incidence and prevalence of epilepsy in children are high [1]. Epilepsy is associated with increased morbidity and mortality in the pediatric population as these children frequently have concomitant neurodevelopmental disorders, and epilepsy may develop in the setting of a genetic disorder affecting several organs [2]. There are suggestions that children with epilepsy visit the emergency department (ED) at a higher rate than adults [3]. Furthermore, about one out of six children with epilepsy have refractory epilepsy requiring complex and often combined therapeutic approaches [2]. Altogether, these factors suggest a high financial burden of epilepsy in children. Extant studies on epilepsy cost in children are scanty and have yielded conflictual results. For example, Cramer et al. have estimated that the overall mean annual direct cost for epilepsy in children was $20,768 [4] while Yoon et al. reported a mean yearly direct cost of $6379 [5]. Those studies have generally been limited to major commercial insurance beneficiaries [4], to children with active epilepsy [6], or to specific therapeutic interventions such as ketogenic diet or hemispherotomy [7,8], limiting the generalizability of results. Studies that have had a national reach are available in Europe. For example, in a prospective cohort of Danish children with epilepsy, the cost of epilepsy was twice as high as in controls without epilepsy [9]. Studies using nationally representative data in the United States (US) are more than a decade old [5], therefore not taking into account recent trends in drug developments, epilepsy surgery, and changes in health policies such as the Affordable Care Act (ACA) signed into law in March 2010. Moreover, previous studies did not include multiple cost components.

Updated cost estimates are needed to inform decision makers on priorities and interventions best tailored to address the important problem of healthcare cost in populations with epilepsy. Such cost estimates should ideally be updated, be representative of the nation, include multiple cost components, and use robust statistical approaches. This study is a contribution to an updated and detailed contribution to direct cost estimate of epilepsy in children using the recently available

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(from 2003 to 2014) data from the largest nationally representative survey of medical costs in the US.

2. Methods

2.1. Data source and population

We conducted a retrospective study among children aged ≤17 years old using data from the 2003–2014 Medical Expenditure Panel Survey (MEPS). The MEPS is a computer-assisted personal interviewing (CAPI) survey collecting information at the household and household members' levels [10]. The MEPS provides nationally representative estimates of healthcare use, expenditure, source of payments, and health insurance coverage. The MEPS Household Components (HC) provides estimates of respondents' health status, demographics, socioeconomic characteristics, employment, access to care, and satisfaction with healthcare using a self-report approach supplemented and validated by the Medical Provider Component (MPC) that requests data on medical and financial characteristics from hospitals, physicians, home healthcare providers, and pharmacies. The MEPS panel design includes 5 rounds of interview covering two years, and the survey builds the information from interview to interview [10,11]. Data collection is designed in such a way that 5 rounds of interviews cover two years each and the MPC validates the responses. Households participating in the survey are selected from the previous year's National Health Interview Survey (NHIS) which provides a nationally representative sample of the US civilian noninstitutionalized population and reflects an oversample of Blacks and Hispanics. Each annual MEPS-HC sample size is about 15,000 households [11]. By merging 12 years of data, we aimed at increasing sample size and stability of estimates. Definition of epilepsy was based on the clinical classification codes (CCC)-83, recorded in the medical condition files [11]. Detailed information on MEPS are available at www.meps.ahrq.gov. In this analysis, we accounted for the complex survey design and population-based weights that adjust for selection probabilities and nonresponse. This approach was used to obtain nationally representative estimates for noninstitutionalized civilian US children [10].

2.2. Statistical analyses

All analyses were performed at the person-level using STATA 14 [12]. The dependent variable was total direct medical expenditures, which are a combination of inpatient hospital expenditure, hospital outpatient expenditure, prescription medicine expenditure, emergency room expenditure, home healthcare expenditure, and other medical expenses [10]. The primary predictor was epilepsy. The adjusted expenditure attributable to epilepsy was computed after adjusting for the following extraneous factors: sex, age, race/ethnicity, education, insurance status, census region, income level, marital status, Charlson Comorbidities Index (CCI), developmental disorders, and year category in order to estimate the adjusted expenditure attributable to epilepsy. “Developmental disorders” was identified using the CCC-83 of 645. Age was classified into three groups: <6 years, 6–11 years, and 12–17 years. Insurance status was classified into three groups: any private, public only, and uninsured. The following census regions were included in the analysis: Northeast, Midwest, South, and West. The following income level categories, representing different percentages of poverty level, were considered: poor (<125%), low income (125% to <200%), middle income (200% to <400%), and high income (≥400%). Usual source of care was dichotomized into “Yes” and “No”, and perceived health status was divided into excellent/very good vs. good/fair/poor. The CCI was adopted from D'Hoore and colleagues using a weight score of 17 conditions [13]. The CCI was grouped into three categories: 0, 1, and ≥2. Developmental disorders were dichotomized into “Yes” and “No”.

Comparison of sociodemographic characteristics by epilepsy status was done using chi-square. We compared the unadjusted mean expenditure between children with epilepsy and those without epilepsy. We also compared the unadjusted mean expenditure among children with epilepsy with developmental disability status. The skewness of cost data distribution resulting from frequent zeros prompted us to use a two-part model gamma distribution and log link for the estimation of incremental cost incurred by epilepsy. This model is a stepwise combination of a probit model for the probability of observing a zero versus positive medical expenditure and a generalized linear model to estimate the adjusted association of healthcare expenditures given a positive medical expenditure [14,15]. In order to verify the fitness of the model and the adequacy of a gamma distribution with a log link as the best-fitting generalized linear model (GLM) for consistent estimation of coefficients and marginal effects, we applied a modified Park Test. Multicollinearity problem tested was among the predictors of the model and was absent as verified by the variance inflation factor. The level of statistical significance was set at $p < 0.05$. The 12-year medical cost data (2003–2014) were inflated to the current estimate of 2016 dollar value using the consumer's price index from the Bureau of Labor Statistics (BLS) [16].

3. Results

3.1. Population characteristics

We included 54,393,387 (weighted) US children aged ≤17 years, 457,873 (0.84%) of whom had epilepsy. The frequency of epilepsy was higher in non-Hispanic Blacks, in those who are publicly insured, in poor families, in those having usual source of care, in individuals who had a good/fair/poor perception of health status, in those with medical comorbid conditions (CCI), and in those with developmental disorders (Table 1).

3.2. Annual unadjusted cost for children with epilepsy and without epilepsy

Compared with children without epilepsy ($2024 [95% confidence interval [CI]: 1917–2130]), children with epilepsy had nearly six times higher unadjusted total expenditure ($12,577 [95% CI: 7922–17,231]). Unadjusted inpatient expenditure for epilepsy ($4418 [95% CI: 1550–7285) was ten times higher than that for participants without epilepsy and represented more than one-third of unadjusted total direct cost. In the same line, unadjusted outpatient, medication, emergency room, and home healthcare expenditures were consistently higher in children with epilepsy compared with those without epilepsy (Table 2).

3.3. Annual unadjusted cost of children with epilepsy by developmental disorder status

Annual unadjusted total healthcare expenditure among children with epilepsy and developmental disorders ($29,227 [95% CI: 19,775–38,678]) was nearly three times as high as in those with epilepsy and no developmental disorders ($11,974 [95% CI: 7146–16,803]). Along the same line, home healthcare expenditure was nearly seven times higher in children with epilepsy and developmental disorders ($15,535 [95% CI: 8080–22,990]) than in those with epilepsy and no developmental disorders ($2343 [95% CI: 275–4411). Home healthcare expenditure for children with epilepsy and developmental disorders represented over 50% of the total unadjusted expenditure; (Table 3).

3.4. Adjusted incremental cost for children with epilepsy

The adjusted incremental total expenditure in children with epilepsy, compared with their counterparts, was $8317 (95% CI: 3410–13,224). The adjusted incremental inpatient expenditure for children with epilepsy was $2893 (95% CI: 651–5134) compared with