



Health resource utilization varies by comorbidities in children with epilepsy



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ABSTRACT

Objectives: Comorbidities in adults with epilepsy have been shown to significantly increase health resource utilization (HRU). The current study aimed to determine whether a similar association exists among children with epilepsy in a universal health insurance system.

Methods: Health administrative databases in Ontario, Canada were used to evaluate the frequency of neurologist visits, emergency department (ED) visits, and hospitalizations. We evaluated the association between HRU and comorbidities, including depression, anxiety, learning disability, attention deficit hyperactivity disorder (ADHD), and autistic spectrum disorder (ASD), adjusting for age, sex, residence, and socio-economic status.

Results: The frequency of neurology visits was increased by comorbid depression, ASD, and learning disability (adjusted relative risk [aRR] = 1.29–2.07; $p < .01$). The frequency of ED visits was increased by all comorbidities (aRR = 1.26–2.83; $p < .0001$). The frequency of hospitalizations was increased by comorbid depression, anxiety, ASD, and learning disability (aRR = 1.77–7.20; $p < .0001$). Learning disability had the largest impact on HRU. For each additional comorbidity, the frequency of neurology visits, ED visits, and hospitalizations increased by 1.64 to 3.16 times ($p < .0001$).

Conclusions: Among children with epilepsy, mental health and developmental comorbidities were associated with increased HRU, and different comorbidities influenced different types of HRU. In addition, we highlight the importance of identifying and managing these comorbidities, as they increased the risks of costly HRU such as ED visits and hospitalizations.

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1. Introduction

Epilepsy is one of the most common neurological disorders in children, with a prevalence of 3.1–8.4 per 1000 in North America [1–3]. Children with epilepsy frequently have mental health and developmental comorbidities such as depression, anxiety, learning disability, attention deficit hyperactivity disorder (ADHD), and autistic spectrum disorder (ASD), adding to the need for medical care [1,4]. Accordingly, approximately 90% of health resources utilized by patients with epilepsy are for nonepilepsy-related conditions [5,6]. Similarly, we have shown that 89% of emergency department (ED) visits and 57% of hospitalizations in children with epilepsy were for nonepilepsy-related conditions [7]. Mental health and developmental comorbidities may contribute to nonepilepsy-related health resource utilization (HRU) in children with epilepsy. Adults with epilepsy and comorbidities utilize

more health care resources than those without comorbidities [8–11]. Specifically, adults with epilepsy and comorbidities are four times more likely to be admitted to a hospital than those without comorbidities [8]. The relative risk of admission and cost of hospitalizations are highest in patients with epilepsy and depression [8]. Comorbid depression increases the frequency of HRU by four times, even when controlling for seizure status among adults with epilepsy [12]. Similarly, adults with both epilepsy and intellectual disability have increased rates of hospitalizations compared with those with intellectual disability alone [13].

There is minimal literature on the influence of comorbidities on HRU in children with epilepsy [14]. The aim of this study was to assess the relation between mental health and developmental comorbidities and HRU in children with epilepsy in a universal health insurance system.

2. Methods

This study was approved by the Research Ethics Board at the Hospital for Sick Children in Toronto, Ontario.

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2.1. Study population

Multiple linked administrative databases in Ontario, Canada were leveraged to identify children with epilepsy aged 0–18 years using the International Classification of Diseases (ICD)—10 code G40.x [7]. The ICD-10 coding for epilepsy has been validated within Canada [15] and the databases utilized in the current study [16]. Previously validated criteria [16] used to identify children with epilepsy included three physician billing codes separated by at least 30 days or one hospitalization over a two-year period, from January 1st, 2011 to December 31st, 2012. The HRU evaluated included the number of neurologist visits, ED visits, and hospitalizations for the period of January 1st, 2013 to December 31st, 2013.

2.2. Study measures and data sources

Neurology visits were identified by the ICES Physician Database (IPDB) [17] and the Ontario Health Insurance Plan (OHIP) physician claims database. The OHIP claims database contained billing information on referrals and office visits for all physicians remunerated on a fee-for-service basis. Emergency department visits and hospitalizations were identified from the Canadian Institute for Health Information (CIHI) hospital discharge abstracts, the National Ambulatory Care Reporting System (NACRS), and the Same Day Surgery (SDS) databases, which contain validated diagnostic and procedural information for all ED visits and hospitalizations in Ontario [18].

The ICD-10 codes from all physician billings, ED visits, and hospitalizations from January 1st, 2011 to December 31st, 2012 were also used to identify mental health and developmental comorbidities, including depression (F32x, F33x), anxiety (F41x), ASD (F84), ADHD (F90), and learning disabilities (specific developmental disorders [F80–83x, F88–89x] and intellectual disability [F70–79x]). Each comorbidity was categorized as present or absent. The total number of comorbidities (sum of the binary comorbidity indicators) was also evaluated. Billing codes for mental health visits, including depression and anxiety, have been shown to have high agreement (86.8%) with clinical data [19].

Patient information, including age, gender, and residential postal code, was obtained from the Registered Persons Database (RPDB). Residence location was categorized as rural or urban and determined by the patient's postal code and Statistics Canada Census data from 2011. Socio-economic status (SES) was evaluated using a deprivation index, as we have previously shown that deprivation index quintile was a more sensitive measure of SES than income quintile [7]. The deprivation index was obtained by linking the patients' postal codes with Statistics Canada Census data [20]. The deprivation index, a measure of material and social deprivation, is based on six indicators among individuals aged 15 years or older: 1) the proportion without a high school diploma; 2) the employment or population ratio; 3) average income; 4) proportion living alone; 5) proportion separated, divorced, or widowed; and 6) proportion of single parent families [21]. It was classified into one of five population quintiles, ranked from lowest to highest, with approximately 20% of the population in each group. Deprivation indices were not available for 158 patients, and these cases were excluded from the study.

2.3. Statistical analyses

The statistical software SAS 9.3 (SAS Institute Inc., Cary, NC) was used for data analyses. Descriptive statistics were used to describe the sample including mean and standard deviation for continuous measures and frequency and percentages for categorical variables. Univariate analyses were conducted using logistic regression to assess the relation between HRU (neurology visits, ED visits, and hospitalizations) with age, sex, residence, SES, and comorbidities. Subsequently, the associations between HRU (neurology visits, ED visits, and hospitalizations) with each comorbidity and the total number of comorbidities were evaluated using

Poisson regression, corrected for possible overdispersion and controlling for age, sex, residence, and SES.

3. Results

In total, 19,035 children with epilepsy were included in the study; mean age: 11.58 ± 4.74 years; 10,387 (54.6%) were males, and 2157 (11.3%) resided in rural areas. There were 15,462 (mean visits: 0.81 ± 1.71) neurologist visits, 13,348 (mean visits: 0.70 ± 1.60) ED visits, and 2390 (mean visits: 0.13 ± 0.58) hospitalizations. Depression was seen in 141 (0.7%), anxiety in 167 (0.9%), ASD in 290 (1.5%), ADHD in 104 (0.5%), and learning disability in 574 (3.0%) children with epilepsy.

3.1. Comorbidities and health resource utilization

In the univariate analysis, depression and anxiety were associated with increased odds of overall ED visits (cOR = 2.99 and 3.35, respectively; $p < 0.0001$) and hospitalizations (cOR = 2.76 and 4.01, respectively; $p < 0.0001$) (Table 1). Attention deficit hyperactivity disorder increased the odds of neurology visits (cOR = 1.60; $p < 0.05$), ED visits (cOR = 3.02; $p < 0.0001$), and hospitalizations (cOR = 1.88; $p < 0.05$). Autistic spectrum disorder and learning disability increased the odds of neurology visits (cOR = 3.15 and 3.66, respectively; $p < 0.0001$), ED visits (cOR = 1.95 and 4.28; $p < 0.0001$), and hospitalizations (cOR = 3.53 and 11.02; $p < 0.0001$).

In the multivariate analysis, depression (adjusted relative risk [aRR] = 1.29; $p < 0.01$), ASD (aRR = 1.91; $p < 0.0001$), and learning disability (aRR = 2.07; $p < 0.0001$) increased the risk of neurology visits, after adjusting for age, sex, residence, and deprivation index (Table 2). Depression, anxiety, ASD, ADHD, and learning disability increased the risk of ED visits by 1.26 to 2.83 times (all $p < 0.0001$), and the adjusted risk was highest among children with anxiety. ASD, and learning disability increased the risk of hospitalizations by 1.77 to 7.20 times (all $p < 0.0001$), and the adjusted risk was highest among children with learning disability. Increasing number of comorbidities was associated with higher risk of HRU. For every increment in comorbidity, the risk of neurology visits increased by 1.64 times ($p < 0.0001$), the risk of ED visits increased by 2.16 times ($p < 0.0001$), and the risk of hospitalizations increased by 3.16 times ($p < 0.0001$), after adjusting for age, sex, residence, and deprivation index.

4. Discussion

There are minimal data in the literature on the association between mental health and developmental comorbidities and HRU among children with epilepsy. The current study addressed this knowledge gap and clarified which particular comorbidity increased the likelihood of which type of HRU in a universal health insurance system. We focused on mental health and developmental comorbidities, including depression, anxiety, learning disability, ASD, and ADHD, as these are known and common comorbidities in children with epilepsy [1,22]. We found a lower proportion of children with comorbidities than what has been previously reported [1]. This may represent underreporting or lack of systematic screening for these comorbidities, and we may have identified children who had recently sought and received treatment (in the two years preceding evaluation of HRU) for these comorbidities. The disparity in prevalence of developmental and mental health comorbidities is further discussed below.

We have found that the pattern and risks of increased HRU varied by the presence of comorbidities. Learning disability was the greatest contributor to increased HRU, including outpatient neurology visits, ED visits, and hospitalizations. In particular, among all the comorbidities, learning disability has the highest relative risk of hospitalizations, which was increased by seven-fold. This strong association may reflect the overall poorer health of children with intellectual disability, marked

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