Examining health service utilization, hospital treatment cost, and mortality of individuals with epilepsy and status epilepticus in New South Wales, Australia 2012–2016

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A B S T R A C T

This study examined the health service utilization and hospital treatment cost of individuals with epilepsy by age group, mortality within 30 days, and surgical outcomes for individuals with refractory epilepsy in New South Wales (NSW), Australia. A retrospective examination of linked hospitalization and mortality data for individuals hospitalized with a diagnosis of epilepsy during 2012–2016. Hospitalized incidence rates per 1000 population were calculated, and negative binomial regression was used to examine temporal trends. Mortality within 30 days of hospitalization was identified, along with cause of death. There were 44,722 hospitalizations during the five-year period, with a hospitalization rate of 85.6 per 1000 population (95% confidence interval (CI): 84.7–86.4). Total hospital treatment costs were AUD$402.9 million. Children aged ≤17 years accounted for 32.0% of hospitalizations. Just over half to two-thirds of hospitalizations for each age group were for a principal diagnosis of epilepsy, with 2976 hospitalizations of individuals for status epilepticus. The overall mean hospital length of stay (LOS) for epilepsy hospitalizations was 5.1 days (standard deviation (SD) = 9.0). Thirty-day mortality was highest for individuals aged ≥65 years (6.7%), and epilepsy was identified as the underlying cause of death for 18.2% of deaths. This research has provided insight into the healthcare utilization profiles of individuals with epilepsy at different ages. Epilepsy hospitalizations constitute a substantial cost to the healthcare system, and better overall management of seizures and comorbid conditions is likely to lead to a reduction in the need for hospitalization.

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1. Introduction

Epilepsy is estimated to affect around 50 million individuals worldwide [1]. In Australia, epilepsy and/or seizure disorder is estimated to affect around 1–2% of the population [2,3], equating to between 246,000 to 492,000 Australians living with epilepsy. Epilepsy can affect individuals of all ages, gender, and socioeconomic status [4]. In terms of health service utilization, the profile of healthcare use by individuals living with epilepsy can vary by age group, with children with epilepsy hospitalized more frequently than adults [5,6].

It has been estimated that half the adults living with epilepsy experience at least one other comorbid health condition [7]. Epilepsy can be a common comorbidity for individuals who have an intellectual disability [8,9] and for those with cerebral palsy [10]. Individuals with health conditions, such as brain tumors, commonly experience epilepsy [11], while for individuals who sustain a traumatic brain injury (TBI), this injury could either precede the onset of epileptic seizures or occur as a result [12,13].

Most individuals living with epilepsy are able to control the frequency of their seizures using antiepileptic drugs (AED) [14]. However, around one-third of individuals living with epilepsy are estimated to have AED-resistant or refractory epilepsy [15], and for some individuals, surgery may be one therapeutic option [16,17]. The frequency, type of surgical procedures conducted, and surgical outcomes for patients with refractory epilepsy at a population level in Australia are unclear. In fact, few previous

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population-based studies of epilepsy have been conducted in Australia, with studies of health outcomes of patients with epilepsy focusing on small patient cohorts [18,19], and with none identifying mortality within 30 days of admission and cause of death.

Understanding the profile and cost of healthcare utilization of individuals living with epilepsy is critical for quantifying the existing burden on the healthcare system and for estimating future healthcare resource use. Information on the use of health services for individuals living with epilepsy and, in particular refractory epilepsy, is also critical to determine the need for accompanying support services, particularly following surgery. This study aims to examine the health service utilization and hospital treatment cost for individuals with epilepsy by age group, mortality within 30 days, and surgical outcomes for individuals with refractory epilepsy in New South Wales (NSW), Australia.

2. Method

This was a retrospective analysis of individuals with epilepsy who had a hospital admission during 1 January 2012 to 31 December 2016 identified in linked hospitalization and mortality data in NSW. The NSW is Australia’s largest populated state, with an estimated population of 7.7 million [20]. Ethics approval was obtained from the NSW Population and Health Services Research Ethics Committee (2017/HRE0201).

2.1. Data sources and data linkage

The NSW hospitalization data include information on all inpatient admissions from all public and private hospitals in NSW. Data from private hospitals were only available up to 30 June 2016 and, based on the private hospitalizations over the last 4 years, it is estimated that there was an underenumeration of n = 746 hospital admissions during 1 July to 31 December 2016. Included within the hospitalization data is information on patient demographics, diagnoses, hospital separation type (e.g., discharged, death), Australian-Refined Diagnosis Related Groups (AR-DRGs), and clinical procedures. Diagnosis codes were classified using the International Classification of Diseases, 10th Revision, Australian Modification (ICD-10-AM).

Epilepsy hospitalizations were identified using any of up to 50 diagnosis classifications of ICD-10-AM: G40 ‘epilepsy’ or G41 ‘status epilepticus’. The first hospital admission during this timeframe was identified as the ‘index admission’. Refractory epilepsy was identified using the 5th character of G40, indicating ‘intractable epilepsy’ (i.e., ‘1’), or using a diagnosis of epilepsy or status epilepticus (ICD-10-AM: G40 or G41) and a relevant surgical procedure (excluding individuals with a brain tumor) from up to 50 procedure classifications (i.e., 40703-02, 40703-00, 40703-01, 40706-00 40700-00). The principal surgical procedures for refractory epilepsy within a period of care included the following: partial brain lobectomy (40703-02), cortectomy of brain (40703-00), topectomy (40703-01), hemispherectomy (40706-00), or anterior section of corpus callosum (40700-00).

Mortality data were obtained from the NSW Registry of Births, Deaths, and Marriages (RBDM) and the cause of death unit record file for the period 1 January 2012 to 31 December 2016. The hospitalization and mortality data extracts were probabilistically linked by the Centre for Health Record Linkage (CHERL) in May 2017.

2.2. Identification of comorbidities

The Charlson Comorbidity Index was used to identify 17 comorbidities using diagnosis classifications in hospital records. The number of comorbidities was treated as a categorical variable and categorized as no reported comorbidity, mild–moderate (1–2), and severe (≥3) comorbidity. A 12-month lookback period to 2011 was used for the identification of comorbidities. A number of other relevant comorbid conditions for epilepsy were also identified including the following: Rett’s syndrome (ICD-10-AM: F84.2), cerebral palsy (ICD-10-AM: G80), intellectual disability (ICD-10-AM: F70–F79), depression (ICD-10-AM: F20.4, F31.3, F31.4, F31.5, F32, F33, F44.1, F41.2, F43.2), anxiety disorders (ICD-10-AM: F40–F48), schizophrenia (ICD-10-AM: F20–F29), alcohol misuse and dependence (ICD-10-AM: F10, Y90, Y91, Z50.2, Z71.4, Z72.1), TBI (ICD-10-AM: S06), brain tumor (ICD-10-AM: C71), bacterial meningitis (ICD-10-AM: G00–G03), and viral encephalitis (ICD-10-AM: A83–A87).

2.3. Geographic and socioeconomic status identification

The Australian Statistical Geographical Standard was used to identify rural and urban residents. Remoteness is derived based on distance to service centers, and the five remoteness categories were collapsed into: urban (i.e., major cities) and rural (i.e., inner regional, outer regional, remote, and very remote) NSW. A measure of socioeconomic disadvantage was assigned to each hospital record using the index of relative socioeconomic disadvantage and the statistical local area of residence of the individual. The index consists of measures that reflect relative disadvantage, and the values were partitioned into quintiles from most (i.e., 1) to least disadvantaged (i.e., 5).

2.4. Hospital treatment cost

The AR-DRGs, hospital length of stay (LOS) and episode of care type (i.e., acute and nonacute) were used to estimate hospital costs. Estimates of hospital costs were obtained from national hospital costing estimates [21], and the most recent publicly available NSW cost calculation guidelines [22] were applied. The average cost per AR-DRG included costs for medical and nursing clinical services, nonclinical salaries, pathology, imaging, allied health, pharmaceuticals, intensive and coronary care, operating rooms, emergency departments, supplies and ward overheads, specialist procedure suites, prostheses, staff oncosts (e.g., superannuation, termination, long-service leave, workers’ compensation, recruitment costs), cleaning, linen and food services, and depreciation costs [21]. The average daily cost per AR-DRG was multiplied by the episode of care LOS up to 120 days within a period of care following the index hospital admission. Where an episode of care exceeded 120 days, a flat rate of $200 per day was applied thereafter, excluding long stays for 19 AR-DRGs involving tracheostomies, neonates, and burns [22]. The AR-DRG classifications were not available for private hospitals from 1 July 2014. All costs are in 2009–10 Australian dollars which was equivalent to an average exchange rate of 0.90 United States (US) dollars [23].

2.5. Health utilization and mortality

Thirty-day mortality was calculated from the date of admission of the index hospitalization for the period 1 January 2012 to 30 November 2016 to allow for 30-day follow-up of individuals admitted in November 2016. Twenty-eight-day unplanned hospital readmission was calculated as readmission within 28 days of hospital discharge (excluding deaths postdischarge) for the period 1 January 2012 to 30 November 2016. The calculation of hospital LOS was truncated to three standard deviations (SDs) in order to exclude extreme outliers [24].

2.6. Data management and analysis

All analyses were performed using SAS version 9.4. All hospital episodes of care relating to the one hospitalization were linked to form a period of care. Descriptive statistics were used to examine hospital treatment costs. Denominator data for the number of individuals by age group and sex residing in NSW were obtained from the Australian Bureau of Statistics population estimates [20]. Denominator data for the number of people living with epilepsy in NSW were derived from published estimates of the proportion of the population living with epilepsy for individuals aged ≤17 years (1% of population) [2] and
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