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Temporal trends in pre-surgical evaluations and epilepsy surgery in the U.S. from 1998 to 2009

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Summary
Objective: To analyze trends in utilization of pre-surgical evaluations including video-EEG (VEEG) monitoring, intracranial EEG (IEEG) monitoring, and epilepsy surgery from 1998 to 2009 in the U.S.
Methods: Data from the Nationwide Inpatient Sample were used to identify admissions for pre-surgical evaluations and surgery. Surgical treatment of epilepsy was identified by the presence of primary ICD-9-CM procedure codes 01.52 (hemispherectomy), 01.53 (lobectomy), or 01.59 (other excision of the brain, including amygdalohippocampectomy). We calculated annual rates of pre-surgical evaluations and surgery based on published estimates of prevalence of epilepsy in the U.S. In addition, we examined variations by region and hospital characteristics, and conducted multivariable analysis to detect temporal trends, adjusting for changes in the population. Sensitivity analysis was also conducted using different algorithms to identify the study population and outcomes.
Results: We detected an increase in the rate of hospitalizations related to intractable epilepsy. Similarly, we noted a significant increase in hospitalizations for VEEG monitoring, but not in IEEG monitoring or in surgery. Multivariable analysis and sensitivity analysis confirmed these results. In addition, there was a significant increase in the proportion of pre-surgical evaluations and surgery performed in non-teaching hospitals.
Conclusions: Despite the increase in VEEG monitoring, the availability of guideline and evidences demonstrating benefits of epilepsy surgery was not associated with a greater employment of surgery over time. Nevertheless, access to pre-surgical evaluations and epilepsy surgery is no longer limited to large medical centers.

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Introduction

Epilepsy surgery remains a surprisingly under-utilized treatment option in persons with intractable epilepsy (Engel, 2011), despite accrual of positive outcome data (Wiebe et al., 2001; de Tisi et al., 2011; Engel et al., 2012), evidence-based guidelines (Engel et al., 2003), and the established safety of resective surgery (McClelland et al., 2011; Kaiboriboon et al., 2011). This under-utilization is reflected in studies that have either found no significant changes in referral patterns for surgery after the publications of Class I evidence and national recommendations (Haneef et al., 2010), or have in fact found a decrease in the trend for surgical treatment for epilepsy (Englot et al., 2012). The latter study (Englot et al., 2012) analyzed data from the Nationwide Inpatient Sample (NIS), which used hospitalizations as the unit of analysis. As the U.S. population grew from approximately 248 millions in 1990 to 307 millions in 2009 (U.S. Census Bureau, 2011), the number of hospitalizations for all conditions including epilepsy are expected to increase but whether the rate of increase in hospitalizations is proportionate to the rate of increase in the U.S. population is unknown. Without making the necessary adjustments that reflect population growth, the rate of epilepsy surgery might not be estimated accurately.

We sought to analyze nationwide trends in the utilization of epilepsy surgery over a period of 12 years. Since determination of candidacy for epilepsy surgery requires specific pre-surgical investigations, some of which are inpatient procedures including video-EEG (VEEG) monitoring and intracranial EEG (IEEG) monitoring, we also investigated temporal trends in these diagnostic evaluations. We used published prevalence rate of epilepsy (Hirtz et al., 2007) and U.S. census population estimates (U.S. Census Bureau, 2011) to examine temporal trends in hospitalizations for intractable epilepsy, for pre-surgical evaluations, as well as for surgery, across geographical regions, and by hospital characteristics.

Methods

The study protocol was approved by the Institutional Review Board at Case Western Reserve University.

Data source

This study is a retrospective cross-sectional study using data from the NIS. The NIS is part of the Healthcare Cost and Utilization Project (HCUP) and is maintained by the Agency for Healthcare Research and Quality (AHRQ). From states participating in the HCUP, nearly 20% of all non-federal hospitals selected from a stratified sample contribute data to the NIS. The details of sampling and weighting strategies and their modifications to improve the representativeness of the NIS can be found on HCUP website.(Houchens and Elixhauser, 2006; Agency for Healthcare Research and Quality, 2011) As the data from 1998 onward better represent all hospitals in the U.S., we conducted the analysis using the NIS from 1998 to 2009.

Study population

We selected all discharges with an epilepsy-related primary International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code with mention of intractability (ICD-9-CM: 345.X1 excluding 345.2 and 345.3). After a preliminary exploration of the data, we excluded discharges for patients over the age of 65 from the analysis due to very low number of surgeries performed in this subgroup ($n \leq 10$ admissions). No other exclusion criteria were applied.

Outcomes of interest

The primary outcome of interest was surgical treatment of epilepsy, identified by the presence of primary ICD-9-CM procedure codes 01.52 for hemispherectomy, 01.53 for brain lobectomy, or 01.59 for other excision of the brain, which includes partial brain lobectomy, and amygdalohippocampectomy.

The secondary outcomes of interest included pre-surgical diagnostic tests performed in an inpatient setting including VEEG monitoring (ICD-9-CM: 89.19) and IEEG monitoring (ICD-9-CM: 02.93).

These outcomes were independent from each other. For example, subjects who had surgery might or might not have VEEG and/or IEEG monitoring. Similarly, subjects who had IEEG monitoring might or might not undergo VEEG monitoring.

Independent variables

Our main independent variable was the year of discharge, which was grouped into 2 time periods: 1998—2003 and 2004—2009, representing 6-year periods before and after the AAN published practice parameters on anterior temporal lobectomy in 2003, respectively (Engel et al., 2003). For the regression model, the year of discharge was measured in single year increments.

Other independent variables included sociodemographic factors that predispose persons to access of health services including age, race, and gender. Additionally, we accounted for hospital's characteristics including location/teaching status and geographic region.

Data analysis

Given that each record in the NIS represents a discharge rather than an individual, we used yearly data from the U.S. Census population estimates (U.S. Census Bureau, 2011) and the previously published prevalence rate of 7.1/1000 persons to estimate the total number of persons with epilepsy in the U.S. in each year of our study period (Hirtz et al., 2007). This provided the denominator to calculate rates for comparison over time and across regions.

To account for potentially low specificity and accuracy in medical coding, we conducted sensitivity analysis using 4 different combinations of ICD-9-CM codes to define our population (intractable partial epilepsy, intractable epilepsy, all epilepsy, and all epilepsy and convulsions). We also