The health care burden of patients with epilepsy in the United States: an analysis of a nationwide database over 15 years

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Object. The aim of this study was to analyze the national health care burden of patients diagnosed with epilepsy in the US and to analyze any changes in the length of stay, mean charges, in-hospital deaths (mortality), and disposition at discharge.

Methods. A retrospective review of the Nationwide Inpatient Sample (NIS) database for epilepsy admissions was completed for the years from 1993 to 2008. The NIS is maintained by the Agency for Healthcare Research and Quality and represents a 20% random stratified sample of all discharges from nonfederal hospitals within the US. Patients with epilepsy were identified using ICD-9 codes beginning with 345.XX. Approximately 1.1 million hospital admissions were identified over a span of 15 years.

Results. Over this 15-year period (between 1993 and 2008), the average hospital charge per admission for patients with epilepsy has increased significantly (p < 0.001) from $10,050 to $23,909, an increase of 137.9%. This is in spite of a 33% decrease in average length of stay from 5.9 days to 3.9 days. There has been a decrease in the percentage of in-hospital deaths by 57.9% and an increase in discharge to outside medical institutions.

Conclusions. The total national charges associated with epilepsy in 2008 were in excess of $2.7 billion (US dollars, normalized). During the studied period, the cost per day for patients rose from $1703.39 to $6130.51. In spite of this drastic increase in health care cost to the patient, medical and surgical treatment for epilepsy has not changed significantly, and epilepsy remains a major source of morbidity.

Key words • epilepsy • socioeconomics • outcome • Nationwide Inpatient Sample

It has been estimated that approximately 1% of the US population suffers from epilepsy. Epilepsy is a unique disease to analyze from an economic standpoint. The high prevalence, high morbidity, and low mortality of this disease combine to create a disproportionately high cost of illness compared with other diseases. Analysis of the disease is made difficult by the heterogeneous patient population; although 80% of patients diagnosed with epilepsy will achieve effective remission of the disease after approximately 5 years, a sizeable portion of patients will suffer from medically intractable epilepsy. Recent years have seen different avenues of treatment emerge for such patients, such as new surgical techniques and VNS. New developments in therapy for epilepsy coupled with advances in diagnostic technology have led to an increase in interventions. In spite of this, epilepsy remains a prevalent problem in the acute care setting worldwide.

Several international studies have addressed the epidemiology of health care in epilepsy; however, there are a limited number of papers that have addressed the socioeconomic changes in the care provided in the US. In their review article, Strzelczyk et al. analyzed the cost of the illness of epilepsy, including indirect expenses to patients with epilepsy, by evaluating 22 studies worldwide. These authors also emphasized the need for studies that evaluate the impact that new antiepileptic treatments have had on the current cost of illness in epilepsy in the US. To our knowledge, there are no current studies that have analyzed trends in admissions, cost, and disposition of epilepsy in the US.
This retrospective study aims to analyze trends related to epilepsy in a nationwide database and to examine the health care burden of this disease. This analysis focuses on changes in LOS, mean hospital charge, in-hospital deaths, and disposition of the epileptic patient after hospitalization. By evaluating the data of more than 1.1 million patients admitted to the hospital for epilepsy in the US, we aim to bypass several limitations of international and private studies that include differing standards of care in practice, varying study populations, and heterogeneous economic climates that currently exist worldwide.

Methods

Clinical data were extracted from the NIS for the years 1993 through 2008. The NIS, which is maintained by the Agency for Healthcare Research and Quality, represents a 20% random stratified sample of all discharges from nonfederal hospitals within the US. It is the largest all-payer inpatient care database in the US and contains data from about 8 million hospital stays from 1000 hospitals each year. The NIS is the only national hospital database containing charge information for all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance, and the uninsured. Patients with epilepsy diagnoses were identified using the corresponding ICD-9-CM codes (345.00–345.9) as a primary diagnosis code. Other seizure codes such as febrile seizure (780.31) were not included. The Healthcare Cost and Utilization Project (HCUP) Internet tool (http://hcupnet.ahrq.gov/) was used to extract data on discharges, LOS, mean hospital charges, in-hospital deaths, and disposition of the epileptic patient after hospitalization (accessed October 15, 2010). When accessing the NIS data set through the HCUPnet tool, a weighted factor is already applied and national estimates are generated. A Bureau of Labor statistics tool (http://www.bls.gov/data/inflation_calculator.htm) was used to adjust hospital and national charges for inflation (normalized charges). Population-adjusted rates (discharges per measure of population) were calculated using population estimates generated by the US Census Bureau. The t-test (version 17.0, SPSS, Inc.) was used to determine statistical significance between data sets. A p value < 0.05 was considered significant.

Results

We identified approximately 1.1 million hospitalizations with epilepsy constituting the principal diagnosis (ICD-9-CM codes 345.XX). In this group, there were significant changes (p < 0.001) in all criteria evaluated, including the normalized number of discharges, LOS, normalized charges and national bill, in-hospital deaths, and patient disposition (Table 1).

Changes in Hospital Stay and Cost

The total number of patients with epilepsy seen in the acute health care setting, as measured by total number of discharges with ICD-9-CM coding 345 increased from 1993 (68,676 patients) to 2008 (170,484 patients), representing an increase of 107% (Table 2). The average LOS decreased from 5.9 days in 1993 to 3.9 days in 2008 (Fig. 1). However, adjusted hospital charges per hospitalization increased from $10,050 to $23,909, a relative increase of cost by 137.9% (Fig. 2). The national health care bill for acute care for epileptic patients in 1993 was just over $690,000,000, while the bill in 2008 soared to $2,735,586,000 (normalized charges).

Changes in Disposition After Hospital Stay

In-hospital mortality rates have decreased by 57.9% (Fig. 3). Disposition planning has also evolved over the past 15 years, with several changes in the plan of care for patients once discharged from the acute health care setting. Transfer discharges to other short-term hospitals decreased by 12.5% (Fig. 4). Meanwhile, there has been a

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**TABLE 1: Overall change from 1993 to 2008**

<table>
<thead>
<tr>
<th>Variable*</th>
<th>1993</th>
<th>2008</th>
<th>Δ (% change)</th>
<th>p Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean total no. of discharges</td>
<td>68,676 ± 89</td>
<td>170,484 ± 414</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>normalized discharges</td>
<td>0.27</td>
<td>0.56</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>mean LOS in days</td>
<td>5.9 ± 0.6</td>
<td>3.9 ± 0.3</td>
<td>−33.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mean charges</td>
<td>$10,050 ± 158</td>
<td>$23,909 ± 367</td>
<td>137.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>normalized charges</td>
<td>$10,050</td>
<td>$16,046</td>
<td>59.7</td>
<td></td>
</tr>
</tbody>
</table>

* Mean values are presented as ± SE. The pooled standard error was calculated from all the various codes.
† Continuous variables were compared using the 2-group t-test, and discharge status was compared using the chi-square test.
Changes in the health care burden of patients with epilepsy over 15 years

### TABLE 2: Yearly change

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>mean no. of discharges</td>
<td>68,676 ± 89</td>
<td>68,709 ± 90</td>
<td>51,585 ± 91</td>
<td>48,865 ± 78</td>
<td>48,344 ± 97</td>
<td>51,902 ± 64</td>
<td>46,409 ± 63</td>
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<td>0.27</td>
<td>0.23</td>
<td>0.20</td>
<td>0.17</td>
<td>0.18</td>
<td>0.19</td>
<td>0.17</td>
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<tr>
<td>mean LOS in days</td>
<td>5.9 ± 0.06</td>
<td>5.7 ± 0.02†</td>
<td>5.2 ± 0.05†</td>
<td>4.7 ± 0.03</td>
<td>4.8 ± 0.04†</td>
<td>4.8 ± 0.05</td>
<td>4.9 ± 0.05†</td>
</tr>
<tr>
<td>mean charges</td>
<td>$10,050 ± 158</td>
<td>$12,802 ± 169†</td>
<td>$9,892</td>
<td>$10,480</td>
<td>$10,650</td>
<td>$10,050</td>
<td>$9,892</td>
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<td>normalized charges</td>
<td>$10,050</td>
<td>$10,590</td>
<td>$9,865</td>
<td>$9,434</td>
<td>$10,017</td>
<td>$11,050</td>
<td>$12,613</td>
</tr>
<tr>
<td>no. of patients (%)</td>
<td>53,370 (77.5)</td>
<td>44,165 (67.2)†</td>
<td>39,147 (75.9)</td>
<td>34,771 (75.9)</td>
<td>39,074 (75.9)</td>
<td>38,115 (75.9)</td>
<td>36,531 (75.9)</td>
</tr>
<tr>
<td>in-hospital deaths</td>
<td>1,213 (1.9)</td>
<td>1,056 (1.8)†</td>
<td>1,183 (2.3)</td>
<td>1,168 (2.3)</td>
<td>1,163 (2.3)</td>
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<tr>
<td>routine discharge</td>
<td>1,692 (2.4)</td>
<td>1,242 (2.3)</td>
<td>1,203 (2.3)</td>
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<td>1,203 (2.3)</td>
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<tr>
<td>another short-term hospital</td>
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<td>3,344 (5.9)</td>
<td>3,344 (5.9)</td>
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<tr>
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<td>926 (1.4)</td>
<td>926 (1.4)</td>
<td>926 (1.4)</td>
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<td>214 (0.3)</td>
<td>214 (0.3)</td>
<td>214 (0.3)</td>
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<td>in-hospital deaths</td>
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</table>

*p = 0.01.

* _p_ = not available.
net increase in discharge to other health care institutions of 300% (Fig. 5). Finally, there has been increased utilization of home health care, with an increase of 47.9% in home health services. These values are all summarized in Table 1.

Discussion

As the sensitivity of EEG and other diagnostic modalities that are used to recognize this disease increases, it is natural to assume that there will be a positive correlate in the number of admissions to acute care centers for seizure control. This prediction has been substantiated in our recent analysis of admissions over the 15-year span studied, as evidenced by an increase in the number of patients discharged with epilepsy diagnoses. This increase has occurred despite the relative increases in the specificity of epileptic diagnostic modalities, and the advent of measures such as video-EEG monitoring and personality assessment inventories for ruling out confounding diagnoses, such as psychogenic seizures, that may have falsely increased the perceived health care burden of epilepsy. Although the patient burden has increased dramatically, corresponding medical and surgical modalities of treatment have not yielded adequate results in decreased morbidity for patients, especially for epileptic patients who did not achieve disease control through surgical intervention.

The results of our study highlight the continuous and significant health care burden of epilepsy in the US. The number of hospitalizations associated with a seizure disorder continues to increase with a concomitant increase in charges. Are the increases in these cases due to improved or more accurate diagnoses? Can the increase in cost result in better quality of life? The fact is that epilepsy...
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Fig. 3. Average in-hospital mortality (percentage of patients who were admitted for epilepsy and died) for admissions of patients with epilepsy (ICD-9-CM codes 345.XX) for the years 1993–2008.

Fig. 4. Percentage of epilepsy admissions (ICD-9-CM codes 345.XX) in which the patients were discharged to short-term hospitals for the years 1993–2008.

sy has a heterogeneous presentation with varied treatment modalities. We may not be able to answer these questions, but the findings deserve special attention. First, we noted a dramatic and disproportionate increase in hospitalizations and charges associated with the care of patients with epilepsy. One hypothesis could be that because more epileptic patients are being identified in the emergency department, more are admitted for observation, follow-up imaging, or even surgical intervention, thus increasing costs. Second, we observed more transfers to other health care facilities. This finding may suggest an apparent lack of or limited improvement in status at discharge in this group of patients. Third, a significant decrease was observed regarding the LOS and in-hospital mortality rate. However, the need for increased home health care and skilled nursing facility utilization after discharge may suggest a disconnection between outcomes and the considerable progress in understanding epilepsy and the availability of new treatment options.

Advances in technology, access to video-EEG units, and improvement in the care of the critically ill patient might explain the increased costs of admission, the decreased mortality, and increased discharges to other institutions. In addition, the advent of VNS for treatment of medically and surgically intractable epilepsy was viewed as a turning point for patients upon its release in the late 1990s. In our analysis of the average cost per admission for the epileptic patient, 3 areas of trend were noted. Figure 2 clearly illustrates periods of equivocal growth (in Zones 1 and 3), along with a 7-year period from 1997 to 2003 (Zone 2) with substantial growth. During the period of 1997–2003, the most significant addition to the treatment available for epileptic patients (either medical or surgical care) was the advent of VNS. The increased availability of VNS could potentially explain the augmented costs per admission as well as the decrease in LOS and increase in discharges to other institutions in some of these cases. Nevertheless, VNS has opened the door to another set of
medically resistant epileptic patients with limited options for the treatment of their disease.

The NIS database has been widely used to analyze trends and outcome. Nonetheless, it represents only a 20% random, stratified sample of all patient discharges from nonfederal hospitals within the US. Although absolute conclusions are difficult to reach on the basis of these data, it is reasonable to analyze the relative trends over time. Our study has other limitations, and inaccurate coding of diagnoses and procedures could lead to over- or underestimates of the trends presented in the NIS database. In addition, limitations of the database do not allow for comparison (for example, emergency vs elective admissions) and assessment of “other” comorbidities that may impact the outcome and disposition in this patient population. This issue has been raised before.1,3,10 When it comes to unique procedures, such as implantation of a VNS device, the coding is probably more accurate and consistent. Another limitation is that the data originate from a selected number of US hospitals, which may introduce bias in patient selection.

Conclusions

Trends from a national database reveal consistent increases in hospitalizations and charges for the evaluation and treatment of epileptic patients over a recent 15-year period. Despite increased charges, there were no significant improvements in immediate discharge status in this group during the period analyzed. Further studies are warranted to determine the cause of increased hospitalizations and ways to improve immediate discharge outcomes. The need to evaluate outcomes despite advances in technology cannot be overemphasized. It seems intuitive that a comprehensive evaluation of all forms of epilepsy is arguably best able to target appropriate patients for appropriate therapies.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Vale. Acquisition of data: Vivas, Baaj. Analysis and interpretation of data: Vivas, Baaj. Drafting the article: Vivas. Critically revising the article: Vale, Benbadis. Reviewed submitted version of manuscript: Vale. Approved the final version of the manuscript on behalf of all authors: Vale. Study supervision: Vale.

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References

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