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Seizure (2005) **14**, 46—51

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Estimating the economic burden of status epilepticus to the health care system

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KEYWORDS
Status epilepticus;
Seizures;
Direct cost

Summary

Purpose: Status epilepticus (SE) is a major neurological condition associated with significant morbidity and mortality. No studies to evaluate the cost burden of SE have been performed to date. This study estimates the direct cost related to an inpatient admission for SE in an urban academic medical center.
Methods: Cases of SE were defined based on a standard 30 min or greater seizure duration. The inpatient claims data were analyzed for 192 patients admitted with SE from 1 July 1993 through 30 June 1994. Patient demographic and clinical characteristics associated with increased cost were identified using multiple regression. The direct costs for SE were compared with other common DRGs.
Results: The median reimbursement for a patient with SE was $8417. The average length of stay for all SE patients was 12.9 days. Age groups (17—45 and 46—64) and etiology (acute CNS) were the only patient factors significantly associated with increased cost. SE patients had 30—60% higher reimbursements than patients admitted for other acute health problems including acute myocardial infarction or congestive heart failure.
Conclusions: The direct inpatient costs for SE are high compared with the direct costs of admissions for other major conditions such as acute myocardial infarction or congestive heart failure. Data from this study were used to estimate a $4 billion annual direct cost for inpatient admissions for SE. Given the incidence and the high costs, further more detailed evaluation of these costs may be useful in assessing the adequacy of reimbursement for this subset of patients with epilepsy.
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1059-1311/$ — see front matter © 2004 Published by Elsevier Ltd on behalf of BEA Trading Ltd.
doi:10.1016/j.seizure.2004.06.001

Background

Studies assessing the cost-of—illness of various neurologic diseases including epilepsy, refractory epilepsy, and stroke have demonstrated a high economic burden of these diseases on the health care system, the patient and their families.[1—8] Because this is a heterogeneous disease, the range in the costs of epilepsy varied widely, depending on the method and focus of the analysis, whether direct and indirect costs were included, or whether the disease is new onset or established.[2,9] The economic burden of epilepsy is high, with the greatest cost per person occurring in the first year of diagnosis and ranging from $917—3157. The costs in subsequent years have been estimated to be lower, ranging from $245—641.[4,8] Status epilepticus (SE) represents an important subset of the epilepsy population because it is a major neurological and medical condition associated with significant morbidity and mortality.[10—15] Estimating the costs attributable to this entity independent of other epilepsy disorders may be important not only because of the severity of this disease, but also because of the substantial number of cases. Epidemiologic data from the Richmond, Virginia metropolitan area determined that the annual incidence of SE was 41 episodes/100,000 adults per year in the United States. This would result in approximately 200,000 cases occurring each year.[10] SE may also occur in association with other diseases such as metabolic coma, or may be associated with neurologic conditions such as stroke, tumor or hypoxic brain injury, further complicating the measurement of the economic burden of this disease.[12] Given the high incidence and the associated morbidity and mortality of SE [10—12,16,17] the economic burden of this disease is likely to be significant. To date, there have been no studies that have estimated the costs related exclusively to status epilepticus.

Methods used to estimate the economic burden of epilepsy have varied because of differences in the inclusion of different components of health care costs such as the direct medical costs to the health care system or to the patient.[4,6,7] Indirect costs are an important contributor to the costs of epilepsy, due to ongoing treatments and visits to the health care provider.[4,6—8] The majority of publications that have assessed the costs of epilepsy have used an annual cost estimate because it is difficult to define an episode of care for epilepsy.[2,5,8,9] Unlike other forms of epilepsy, SE may lend itself better to identifying an episode of care related to a hospital admission. That admission is likely to represent the largest proportion of direct costs to the health care system. Given that the incidence burden of disease is substantial, and that the SE events are most likely to occur in a high health care cost setting, studies to estimate the cost of SE independent of that for other seizures seems warranted.

Data from the NIH Greater Metropolitan Area Status Epilepticus Data System provided a unique opportunity to assess the economic burden to the health care system associated with an inpatient hospital admission for SE. Because the patients were identified prospectively and comorbidity information was collected the effect of other diagnoses on the direct costs surrounding an episode of SE could be examined. Finally, costs measured by reimbursement and associated with an SE admission, were compared with those for other acute admissions including myocardial infarction, stroke, and congestive heart failure.

Methods

Case definition

SE has been defined for all studies related to this project using well-established criteria as (1) any seizure lasting 30 min or longer; or (2) intermittent seizures totaling more than 30 min, between which the patient did not regain consciousness.[10,11,13,15,18]

Population

The Medical College of Virginia of Virginia (MCV) Commonwealth University prospectively collects and maintains epidemiologic and clinical data on SE in the Greater Richmond Metropolitan Area Status Epilepticus Data System.[10,14] Data on a subset of these patients, cases diagnosed and treated at MCV Hospital, were used to assess the direct medical costs as represented by reimbursement for inpatient stays for SE. The inpatient claims data for 192 patients admitted to the MCV Hospital from 1 July 1993 through 30 June 1994 were analyzed to calculate the direct economic burden of an episode of SE.

Patients admitted with an admission DRG of acute myocardial infarction, cerebrovascular hemorrhage, or congestive heart failure in 1994 were identified and claims data were used to estimate the direct costs of inpatient medical care for these diseases. The direct costs measured as reimbursement provided a set of relative comparisons for the same costs associated with an admission for SE.

Costs

Because SE is treated primarily in the acute inpatient setting, the largest proportion of the costs of

medical care for SE are likely to occur during the inpatient admission in which the SE is diagnosed and treated. We did not attempt to capture indirect costs to the health care system, or other indirect costs such as those incurred by the patient or family for treatment of their condition. The purpose of this study was to obtain a measure of the economic burden of SE to the health care system, and to compare that with the burden for other disease entities. This was based on the reimbursement to our health care system for a hospital admission for SE. The relative costs for an SE admission versus those for admissions for three other major diseases were compared. The comparison was based on the ratio of the reimbursement for admissions to our institution. These results are presented as the ratios of the average reimbursement amount for an inpatient stay for SE divided by those for a specific diagnosis (acute myocardial infarction, congestive heart failure or cerebrovascular hemorrhage). This ratio provides a relative measure of the direct health care costs of SE that controls for the potential variation in reimbursement rates across institutions.

Analysis

Patients were categorized for analysis into four age groups: 0—16, 17—45, 46—64 and 65 and older. They were also categorized by gender and by a dichotomous race variable (white/black). Etiologies were grouped into five general categories as defined previously: hypoxia (anoxic and hypoxic insults), central nervous system (CNS) acute etiologies (stroke, tumors, trauma and CNS infections), nonCNS acute (metabolic disorders, systemic infections, and drug overdose), withdrawal (alcohol and anti-epileptic drug withdrawal and undermedication for seizures) and cases related to a remote or congenital origins (resolved stroke, birth injury, or congenital anomaly).[10,17,19,20]

Other conditions that were included in the comparison of SE to other inpatient stay reimbursements were selected based on Diagnosis Related Groups (DRG) and International Classification of Diseases 9th Edition (ICD-9) principle diagnosis. For intracranial hemorrhage, cases with DRG 014 and a principle diagnosis of 431, 434.91 were selected. For CHF, cases with DRG 122 or 124, associated with a principle diagnosis of 428 were selected. Acute myocardial infarction cases included those with DRG 121, or 122 and a principle diagnoses of 410. Inpatient stays for seizure (which included primarily status stays) had DRGs 024 and 025 with a principle diagnoses 345 or 780.3.

The Statistical Analysis System (SAS) Univariate procedure was used to calculate the mean, median and interquartile ranges for reimbursement. The interquartile range is the estimate between the 25th and 75th percentile. Nonparametric procedures from the SAS Npar1way Procedure, including the Median test and the Wilcoxin Rank sum test were performed to assess differences in reimbursement across age, race, sex, and etiologic groupings. For the univariate comparisons, median costs were used to reduce the impact of a skewed distribution.

Reimbursement amounts were calculated based on the natural logarithm of the dollar amount. Using the natural log to perform statistical calculations and then transforming back to dollars reduces the effect of skewedness of any cost data, and provides a normalized distribution required for linear regression modeling. The SAS General Linear Models procedure was used to perform multiple linear regression to identify factors significantly and independently associated with increasing cost among SE patients. Length of stay (LOS) was based on the total number of days for each inpatient stay.

The relative direct cost burden of SE was compared with that for other diagnoses during an acute inpatient admission. The ratio of the average inpatient reimbursement for SE was divided by the average reimbursement amount for other specific conditions including intracranial hemorrhage, congestive heart failure (CHF), and acute myocardial infarction (AMI).

Results

A description and frequency distribution of the study population by age group, race, sex, and SE etiology are presented in Table 1. The estimates of the median and interquartile range in reimbursement for each of the demographic and etiologic groupings for inpatient stays related to SE are presented in Table 2. Reimbursement differed significantly across age groups and across etiologies in this univariate comparison. There were no significant differences by race or gender. Of 192 patients included in this cohort and admitted with a diagnosis of SE in 1993—1994, the median inpatient reimbursement was $8,417 with an interquartile range of $5592—$21,155. The average length of an inpatient stay for these cases was 12.9 days with an interquartile range of 3—15 days. The median direct cost as reflected by reimbursement and average length of stay for an inpatient hospital stay was $1458 per day.

There was a nearly three-fold significant difference in the range of cost estimates based on reimbursement by age group (P = 0.002). The lowest

Table 1 Status epilepticus (SE) Population[a].

	N[b] (%)[c]
Total population	192
Age group	
0—16	70 (36)
17—45	46 (24)
46—64	38 (20)
65+	38 (20)
Race	
Black	62 (32)
White	130 (78)
Sex	
Male	113 (59)
Female	79 (41)
Etiology	
CNS Acute	43 (22)
Hypoxia	21 (11)
NonCNS acute	49 (26)
Remote/congenital	57 (30)
Withdrawal	22 (11)

Description: demographics and SE etiology.

[a] The SE population in this study consisted of all admission for, SE to a large, urban academic hospital between 1 July 1993—30 June 1994.

[b] *N*: the number of patients with that characteristic in the study population.

Table 3 Multiple logistic regression results predicting increased cost associated with inpatient stays for status epilepticus (SE).

Patient characteristic	Cost multiplier[b]	*P*-value
Intercept (baseline cost)[a]	6483.40	0.0001
Female	1.14	0.36
Black race	0.98	0.88
Age 17—45[c]	1.95	0.0006
Age 46—64[c]	1.74	0.008
Age 65+[c]	1.32	0.2
Hypoxia[d]	1.56	0.095
CNS acute[d]	2.23	0.0004
Remote/congenital[d]	0.89	0.53
Withdrawal[d]	1.03	0.91

[a] Charges for a white, male SE patient, age 0—16 with nonCNS acute etiology;.the SE patient with the lowest inpatient cost.

[b] Factor by which baseline cost is multiplied for that patient characteristic. For example: SE patients aged 25 have 1.95 times the cost of SE patients aged 0—16 years ($12,642.63).

[c] ''0—16'' age group is the comparison group for each of the other 3 age groups. The cost for SE patients aged 65+ is not significantly different than for SE patients aged 0—16 years.

[d] NonCNS acute is the comparison group for each of the four other etiologies.

were in the pediatric age group (0—16 years) and the highest in the adult age group (17—45 years) as shown in Table 2. A significant, 2.5-fold variation was observed in reimbursement for SE according to etiology ($P = 0.0008$). The highest were for the acute CNS category and the lowest in the nonCNS Acute category. Patients with an etiology of withdrawal from alcohol or anti-epileptic drugs had the second

Table 2 Direct costs (reimbursement) for an inpatient admission for status epilepticus by patient demographic characteristics and etiology.

Patient characteristics	Reimbursement[a]		
	Median	25th percentile	75th percentile
Total	$8,417	$5,592	$21,155
Age group[b]			
0—16	$6,140	$3,423	$14,795
17—45	$14,689	$7,892	$26,604
46—64	$9,520	$5,449	$22,731
65+	$8,938	$7,514	$18,870
Race[c]			
Black	$8,601	$5,449	$32,735
White	$8,039	$5,419	$19,504
Sex[c]			
Male	$8,135	$5,492	$21,260
Female	$8,234	$5,410	$21,313
Etiology[b]			
CNS Acute	$16,919	$8,092	$39,620
Hypoxia	$9,738	$8,037	$23,747
NonCNS acute	$6,669	$3,823	$14,021
Remote/congenital	$7,090	$4,328	$13,992
Withdrawal	$11,239	$6,136	$20,360

[a] Reimbursement dollars are based on hospital inpatient claims for 1993 and 1994.

[b] There are statistically significant differences in reimbursements across age groups ($P = 0.002$) and etiology ($P < 0.001$).

[c] There are no statistical differences in reimbursement by race ($P = 0.75$) or gender ($P = 0.9$).

Table 4 Comparison of the ratio of reimbursement for status epilepticus inpatient stays with other common diagnoses.

Admission diagnosis	Number of admissions[a]	Average LOS	Average reimbursement per admission[b]	Reimbursement ratio of SE/other Dx
Acute myocardial infarction	81	7.26	$10,393.14	1.81
Congestive heart failure	82	7.48	$9,684.72	1.94
Intracranial hemorrhage	62	9.30	$11,547.71	1.63
Status epilepticus	192	12.92	$18,834.88	1.00

[a] Inpatient admissions to an urban academic medical center between 1 July 1993—30 June 1994 one with a principle diagnosis and DRG code listed in column.

[b] Average reimbursement = total average amount paid to the hospital for inpatient services provided for each of the diagnoses in column one (across all payors).

highest compared with other etiologies. There were no significant differences by gender or race.

The results of the multivariate analysis are provided in Table 3. Neither race nor gender was associated with higher costs for inpatient admissions for SE as reflected by reimbursement. As in the univariate analysis, age and etiology were significant independent predictors of increasing reimbursement. The lowest direct costs in the univariate analysis were found for the pediatric age group (0—16 years). Therefore, this group served as the reference group for the multiple regression. Admissions for SE patients aged 17—45 and 46—64 had significantly increased costs over the pediatric age group, a nearly two-fold increase for those age 17—46, and a 1.74-fold increase for persons aged 46—64. However, reimbursement for inpatient admissions for those in the oldest age group (65+) were not significantly higher than for the pediatric age group, even after adjusting for etiology. SE resulting from a CNS acute etiology had significantly higher costs than were seen for persons in any other etiologic category, including the reference group (nonCNS acute).

Length of stay varied markedly in patients with SE. Slightly over half the patients, 104 of 192 (54%) had a LOS of less than one week (data not shown). The reimbursement for patients increased corresponding to an increased LOS. The average reimbursement for SE patients with less than a one week LOS was approximately $7000, that for patients with over one week stay was $32,907. A substantial number of the SE patients (10%) had an LOS over four weeks for an inpatient admission with a resulting reimbursement of over $60,000 per admission.

Table 4 provides a comparison of the relative costs of an average inpatient admission for SE compared with other common diagnoses (acute myocardial infarction, intracranial hemorrhage, and congestive heart failure). The ratio of costs for SE patients ranged from 1.63 in patients with intracranial hemorrhage to 1.94 compared with patients admitted for congestive heart failure.

Conclusion

SE is associated with significant direct health care costs as reflected by reimbursement, both when associated with other diseases and as an independent etiology. The impact of this disease is substantial both because of the high cost and also because of the number of cases, particularly in the middle-aged and elderly population. In other studies of SE, the elderly population was found to have the highest incidence of SE and an associated mortality of 34%.[11,17] The anticipated rapid expansion of the elderly population over the next two decades will only increase the economic impact of this disease on the Medicare system, reinforcing the necessity of further evaluating the burden of SE from a health policy and reimbursement perspective.

Although the estimate reported in the current study reflects only the acute episode related to the hospital admission for status, it provides a measure of the potential economic impact of this disease. Based on an epidemiologic study of SE by DeLorenzo et al.[10], suggesting that there are approximately 200,000 episodes of SE per year in the U.S. population, the direct costs to the health care system for SE admissions may be as high as $4 billion per year. This estimate is based on inpatient reimbursement from one hospital system, but it is similar in magnitude to the estimate by Murray and others of $1.3 billion per year for refractory epilepsy.[3] The estimated median direct health care costs based on reimbursement of an episode of SE from this analysis were $8417 and were substantially higher than the total average annual costs in the initial year after diagnosis of $3157 for all epilepsy reported by Begley.[8] The costs from the two studies are not directly comparable because of differences in health care settings and methods of estimation, nevertheless, the results suggest that status represents a portion of the epilepsy population with a significantly greater component of direct health care costs.[4,9]

Reimbursement may not accurately reflect the costs of providing health care across different health care settings. However, comparing the ratio of costs within the same health care system for SE and other diagnoses provides a relative measure of the magnitude of health care costs associated with an episode of SE. In this study, an inpatient admission for status was associated with a 60—90% greater direct cost than that for admissions with other diagnoses.

Further study is needed to evaluate the additional direct costs of SE for physician visits, outpatient care, laboratory tests and pharmacy charges as well as emergency department care, and to evaluate in more detail the impact of comorbid conditions on the LOS and costs for SE. Further, reimbursement is a measure of the economic burden to the health care system, but may not accurately reflect the costs to the entity providing care, and does not include the direct and indirect costs to the patient and his family. A study providing information on the longitudinal health care costs of SE that includes inpatient and subsequent outpatient care as well as costs of readmission would provide important information on the total costs of sequelae of this condition. As new treatments for SE are developed, this type of analysis would permit an assessment of their effectiveness from an economic perspective. Given the significant morbidity and cost burden associated with this diagnosis, further efforts towards refining the costs of this disease are indicated. The results of a more complete analysis may be useful in establishing and refining reimbursement rates or in defining this disease as an independent diagnostic category for reimbursement.

Acknowledgement

This research was supported by NIH P50 NS25630.

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