DOI:10.4274/tnd.2022.99233
Turk J Neurol 2022;28:45-50

Original Article / Özgün Araştırma

Hospitalization Cost in Patients with Non-convulsive Status Epilepticus: Is it Different from Other Critical Care Patients?

Non-konvülsif Status Epileptikuslu Hastalarda Yatış Maliyeti: Diğer Yoğun Bakım Hastalarından Farklı mı?

Cansu Ayvacıoğlu Çağan, Okan Sökmen, Ethem Murat Arsava, Mehmet Akif Topçuoğlu, Neşe Dericioğlu
Hacettepe University Faculty of Medicine, Department of Neurology, Ankara, Turkey

Abstract

Objective: Status epilepticus (SE) is one of the severe neurological emergencies with significant morbidity and mortality. Most of the time these patients require admission to intensive care units. There is little information about health-economy related burden of SE and potential factors affecting cost except for developed Western countries, especially from the perspective of non-convulsive SE (NCSE).

Materials and Methods: We included all consecutive patients diagnosed as having NCSE with continuous electroencephalogram (EEG) in our neurological intensive care unit (NICU) between 2009 and 2019. Demographic and clinical features were collected from patient files. Total cost during NICU care was obtained from hospital financial records. The results were compared with other NICU patients (control group) followed during the same period for the same length of stay. We also investigated the potential impact of several parameters on cost.

Results: Thirty two patients with NCSE and 32 controls were included. Mean cost per patient was 11,831 US dollars (USD) in the study and 11,240 USD in the control group (p=0.386). Increased length of stay (p<0.001), lower Glasgow Coma scale score at admission (p=0.003), and new diagnosis of NCSE after admission to NICU (p=0.018) were significantly associated with higher cost in study group. SE related direct costs (anti-seizure medicines, anesthetics and continuous EEG) comprised only 3% of total NICU care expenditures.

Conclusion: Management for NCSE in NICU leads to significant intensive care related cost. The similarity of the cost level to other NICU patients indicates that most of the expenditures are related to intensive care, rather than management of seizures. We found that a few patient-related parameters could significantly affect the cost, but they were all non-modifiable.

Keywords: Non-convulsive status epilepticus, neurological intensive care unit, health related cost, continuous EEG monitoring

Öz

Amaç: Status epileptikus (SE), ciddi morbidite ve mortaliteye neden olan nörolojik acil durumlardan biridir. Çoğu zaman bu hastaların yoğun bakım ünitelerinde takibi gerekir. Özellikle non-konvülsif SE (NKSE) perspektifinden bakıldığında, SE'nin ekonomik yükü ve maliyeti etkileyen potansiyel faktörler hakkında çok az bilgi vardır.

Gereç ve Yöntem: 2009-2019 yılları arasında nöroloji yoğun bakım ünitemizde (NYBÜ) video- elektroensefalogram (EEG) monitörizasyonu ile NKSE tanısı almış tüm hastaları dahil ettik. Demografik ve klinik özellikler hasta dosyalarından tarandı. NYBÜ bakımı sırasındaki toplam maliyet, hastanenin mali kayıtlarından elde edildi. Sonuçlar, aynı süre ve aynı kalış süresi boyunca takip edilen diğer NYBÜ hastaları (kontrol grubu) ile karşılaştırıldı. Maliyet üzerindeki potansiyel etkili olabilecek parametler gözden geçirildi.

Bulgular: Otuz iki NKSE hastası ve 32 kontrol grubu hastası dahil edildi. Çalışmada hasta başına ortalama maliyet 11.831 Amerikan doları (USD), kontrol grubunda 11.240 USD idi (p=0,386). Artan yatış süresi (p<0,001), gelişte daha düşük Glasgow Koma skoru (p=0,003) ve NYBÜ takibi sırasında NKSE gelişmesi (p=0,018) maliyetle anlamlı olarak ilişkili bulundu. SE ile ilgili doğrudan maliyet (anti-epileptik ilaçlar, anestetikler ve video-EEG monitörizasyonu) toplam NYBÜ bakım harcamalarının yalnızca %3'ünü oluşturuyordu.

Sonuç: NYBÜ'de NKSE yönetimi yüksek maliyete yol açmaktadır. Toplam maliyetin diğer NYBÜ hastalarına benzerliği, harcamaların çoğunun nöbet yönetiminden çok yoğun bakımla ilişkili olduğunu göstermektedir. Hastalarla ilişkili bazı parametrelerin maliyeti önemli ölçüde etkileyebileceği gösterilmiştir ancak bunlar değiştirilemez faktörlerdir.

Anahtar Kelimeler: Non-konvülsif status epileptikus, nöroloji yoğun bakım ünitesi, sağlıkla ilişkili maliyet, video-EEG monitorizasyonu

Address for Correspondence/Yazışma Adresi: Neşe Dericioğlu Prof. MD, Hacettepe University Faculty of Medicine, Department of Neurology, Ankara, Turkey
Phone: +90 312 305 18 09 E-mail: nesedr@hacettepe.edu.tr ORCID: orcid.org/0000-0003-2465-3017
Received/Geliş Tarihi: 02.03.2021 **Accepted/Kabul Tarihi:** 07.02.2022

Introduction

Status epilepticus (SE) is a life-threatening condition with a pooled crude annual incidence rate of 12.6/100,000 (1). Because of the significant mortality rate (13-19%) (2), patients frequently require close follow-up in the neurological intensive care unit (NICU). Despite the growing number of publications on SE, health related expenditures of SE have gained little attention. Former publications on this topic have reported divergent but significant quantities. Considering the high incidence of SE, a population level extrapolation predicted that >200 million ∈ or 4 billion United States dollars (USD) might be spent each year in Germany or the US, respectively (3,4,5,6).

In this cohort of patients, cost is determined by numerous factors such as supporting infrastructure, specialized manpower, laboratory investigations, various interventions, electroencephalogram (EEG) monitoring and drugs (antiseizure medications, anesthetics and others). Other parameters include, but are not limited to, patient-related demographic variables, etiology, type and severity of SE and ICU-related complications. Very few studies have defined the effects of these parameters on the economic burden of SE (4,5,6,7,8,9,10,11, 12,13,14,15). Only two studies compared cost related to SE with cost in other acute medical disorders (4,9). Most of the publications are from Western societies. Therefore, in this study we aimed to analyze SE related health expenditures in patients with non-convulsive SE (NCSE) who were prospectively followed up in our NICU. We compared the results with patients who were admitted to our NICU for reasons other than SE. We also investigated the potential variables that might be related to cost. To the best of our knowledge, SE related economic burden was not reported previously from non-Western countries like Turkey.

Materials and Methods

Study Design

We reviewed the EEG recordings of all consecutive patients who underwent video-EEG monitoring (VEEGM) in our NICU between November 2009 and June 2019. Most of the time, indication for EEG recording was to rule out the presence of NCSE in patients with otherwise unexplained alterations in consciousness or behavior. Continuous VEEGM (Grass Telefactor Comet, West Warwick, RI) was recorded in a bipolar longitudinal montage, with scalp electrodes arranged according to the International 10-20 System. Filter settings were 1 to 70 Hz, sampling rate was 200 Hz, and sensitivity was adjusted accordingly. Inter-electrode impedances were <5 kΩ. EEG recordings were evaluated on a daily basis. NCSE was defined according to Salzburg criteria (16). We also subdivided patients as those with non-refractory SE (NRSE), patients with RSE (defined as seizure persistence despite administration of one first-line medication and one second-line medication) (17) and patients with super refractory SE (SRSE) (defined as SE that persists despite 24-hour treatment with IV anesthetic or recurs when weaning the patient off the anesthetic) (18). SE severity score (STESS) was calculated in each patient (19). We excluded patients with "possible NCSE", hypoxic ischemic encephalopathy, stimulus-induced rhythmic, periodic, or ictal discharges, or convulsive SE. All EEG recordings were interpreted by a clinical electrophysiologist with special expertise in interpretation of critical care EEG (ND).

The control group was extracted from the patients who were followed up in our NICU for indications other than SE. For each patient in the study group, we identified a control case who was hospitalized in the same year and had the same duration of NICU stay.

Electronic health records were used to obtain information related to demographic features and clinical characteristics of patients in both groups.

The invoiced total hospitalization cost (including laboratory investigations, nurse services, medications, surgical interventions, etc.) for each patient was converted to USD based on the hospitalization year. The cost of VEEGM, anti-epileptic and IV anesthetic medications were also calculated in the study group. We compared the total costs between study and control groups. In the study group, we also explored whether certain clinical and demographic features (i.e., age, gender, GCS at admission, type of SE, STESS, length of NICU stay, reason for hospitalization) could possibly affect the total amount of hospitalization cost.

The study was approved by the Hacettepe University Faculty of Medicine Local Institutional Ethics Committee (approval no: FON 08/19-53, date: 01.05.2008).

Statistical Analysis

Statistical analyses were performed using SPSS v23.0 (IBM SPSS Statistics for Windows, Version 23.0 Armonk, NY). We analyzed the data in terms of normality of distribution by using visual (histograms, probability plots) and analytic (Kolmogorov-Smirnov and Shapiro-Wilk tests) methods.

Comparisons between the study and control groups were performed by using the Independent samples t-test for continuous variables and chi-square test for categorical variables.

Within-group differences were compared by using Mann-Whitney U or Kruskal-Wallis tests for continuous variables and chi-square test for categorical variables.

The effect of factors on total cost in the study group was determined by using linear regression analysis. Significance level was set at $p<0.05$.

Results

We identified 32 patients in the NCSE group. We were also able to select 32 NCSE patients who matched the study group in terms of year of admission to the NICU and length of ICU stay. The demographic and clinical characteristics of both groups are summarized in Table 1. Age, gender and length of stay were similar between the groups. The mean duration of EEG recording in the study group was 134.1 (±99.2) hours.

Twenty-three patients (71.9%) in the study group were hospitalized because of NCSE while the rest (28.1%) developed NCSE during their stay in NICU for other reasons (Table 1). Glasgow Coma scale (GCS) score at admission was ≤8 in 43% of the patients in the study group. The most common underlying etiology of NCSE were ischemic or hemorrhagic stroke (40.7%). The STESS score varied between 2 and 6 among patients with NCSE (Table 1). Considering the type of SE in terms of refractoriness, 14 patients (43.7%) were diagnosed as having NRSE, while the rest (56.3%) had either RSE or SRSE (Table 1).

The median hospitalization cost in the study group was 11 831 USD (mean: 26,569; range: 2,183-140,132 USD), while median cost in the control group was 11,240 USD (mean: 21,668;

Table 1. Demographic and clinical features of the study and control groups

Patient characteristics	Study group (n=32) (mean, SD)	Control group (n=32) (mean, SD)	p value
Age (year)	57.1 (±16.6)	59.2 (±9.6)	0.907
Gender	13 F (40%) 19 M (60%)	13 F (40%) 19 M (60%)	1
Length of stay (day)	34.8 (±28.7)	32.8 (∓26.7)	0.855
EEG recording (hour)	134.1 (±99.2)	-	-
Indication for hospitalization	23 NCSE (71.9%) 9 non-NCSE (28.1%)	23 CVD* (71.9%) 9 Other† (28.1%)	-
NCSE etiology	13 CVD* (40.7%) 9 encephalitis (28.1%) 4 epilepsy (12.5%) 3 intracranial mass (9.4%) 3 other‡ (9.4%)	-	-
GCS score	≤8 in 14 (43%) >8 in 18 (57%)	-	-
STESS score	<4 in 11(34.4%) 4 in 21 (65.6%)	-	-
Type of SE	14 NRSE (43.7%) 7 RSE (21.9%) 11 SRSE (34.4%)	-	-

*Ischemic and hemorrhagic cerebrovascular events, †Neuromuscular diseases (motor neuron disease, myasthenia gravis), Neurodegenerative diseases (Progressive supranuclear palsy, Alzheimer's dementia), Intracranial mass and Encephalitis/metabolic encephalopathy, ‡Metabolic encephalopathy, NCSE: Non-convulsive status epilepticus, CVD: Cerebrovascular disease, GCS: Glasgow Coma scale, STESS: Status epilepticus severity score, SE: Status epilepticus, NRSE: Non-refractory status epilepticus, RSE: Refractory status epilepticus, SRSE: Super-refractory status epilepticus, SD: Standard deviation, F: Female, M: Male

range: 689-111,149 USD) leading to an insignificant difference (p=0.386). In the study group mean cost per patient/day was 775 USD. Cost increased proportionately with the duration of hospitalization in both the study (p<0.001), and control groups (p<0.001) (Figure 1). In addition to the length of stay, lower GCS at admission (p=0.011), higher STESS score (p=0.020) and a new diagnosis of NCSE after admission to NICU (p=0.034) were significantly associated with higher cost in the study group in bivariate analyses (Table 2). Significance survived for low GCS (p=0.003) and detection of NCSE after admission (p=0.018) in regression analysis but not for STESS score (p=0.4) (Table 2). Age, gender and type of SE were not significantly correlated with total hospital cost (Table 2). Length of stay on the other hand, was correlated with lower GCS at admission (p=0.042), higher STESS score (p=0.01) and de novo NCSE diagnosis after NICU admission (p=0.015) (Table 3). Type of SE was not correlated with length of stay after logistic regression analysis. In the study group, costs related to anti-seizure medications, IV anesthetics and VEEGM comprised only 3.1% of total NICU care expenses (Table 4).

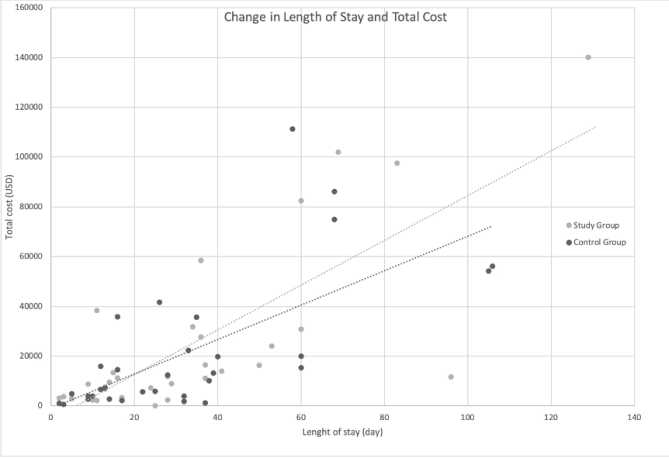

Figure 1. Change in cost in proportion to length of stay in both study (p<0.001) and control groups (p<0.001)

Discussion

In this retrospective cohort study evaluating the cost of hospitalization for patients with NCSE managed in our NICU, we found that median cost was close to 12,000 USD, although there was a wide range between lowest and highest values. Total hospital charges were not different from patients who were cared for reasons other than NCSE. Lower GCS at admission, in-hospital detection of NCSE and longer length of stay were significantly correlated with higher costs. Age, gender and STESS did not significantly affect the results. SE related direct costs such as AEDs, IV anesthetics and VEEG comprised only a small minority of the total sum.

SE management costs may or may not be considerable for a given patient. Nevertheless, considering the incidence of SE in the general population the total amount may reach a huge value. This was calculated as >200 million euros in Germany, and 4 billion USD in the United States (3,4,5,6). Despite this fact, there have been relatively few studies investigating SE related hospital charges. Most are form Western countries (4,5,6,7,8,9,10,11,12,13,14,15), with only two studies from non-Western countries (9,15). **Mean** hospitalization costs for SE in

Table 2. The effect of different parameters on total cost in the study group

Investigated parameters	Total cost (USD) (median, range)	p value*	p value†
Gender			
Female	12682 (2138-140132)	0.863	0.964
Male	11831 (2303-101975)		
Age (year)			
20-40	5375 (2303-13998)	0.895	0.725
40-60	16490 (2282-58421)		
60-80	17942 (2183-140132)		
>80	11670 (11670-22336)		
Indication of hospitalization			
NCSE	10111 (2183-101975)	**0.034**	0.018
non-NCSE	16320 (9478-140132)		
GCS			
≤8	29278 (2282-140132)	**0.011**	**0.003**
>8	9478 (2183-38333)		
STESS			
0-3	8884 (2303-38333)	**0.020**	0.400
4-6	16490 (2183-140132)		
Type of SE			
NRSE	13324 (2183-97495)	0.425	0.085
RSE	9478 (7176-140132)		
SRSE	16320 (2282-101975)		

*p value is for subgroup analysis with bivariate comparison, †p value is for regression analysis with dependent variable for total cost, NCSE: Non-convulsive status epilepticus, GCS: Glasgow Coma scale, STESS: Status epilepticus severity score, SE: Status epilepticus, NRSE: Non-refractory status epilepticus, RSE: Refractory status epilepticus, SRSE: Super-refractory status epilepticus, USD: US dollars

Table 3. Parameters affecting length of stay in the study group

	Length of Stay (days) (median, range)	p value*	p value†
Age (year)			
20-40	13 (2-41)	0.788	0.932
40-60	28.5 (9-83)		
60-80	34 (3-129)		
>80	64.5 (33-96)		
Gender			
Female	29 (11-129)	0.818	0.989
Male	28 (2-96)		
Indication of hospitalization		**0.015**	**0.015**
NCSE	28 (2-69)		
non-NCSE	50 (11-129)		
GCS			
≤8	36.5 (13-129)	**0.005**	**0.042**
>8	15.5 (2-96)		
STESS			
0-3	14 (2-41)	**0.003**	**0.010**
4-6	36 (3-129)		
Type of SE			
NRSE	13 (2-83)	**0.034**	0.775
RSE	24 (14-129)		
SRSE	37 (13-96)		

*p value is for subgroup analysis with Mann-Whitney U, chi-square or Kruskal-Wallis tests, †p value is for regression analysis with dependent variable for length of stay, NCSE: Non-convulsive status epilepticus, GCS: Glasgow Coma scale, STESS: Status epilepticus severity score, SE: Status epilepticus, RSE: Refractory status epilepticus, SRSE: Super-refractory status epilepticus

different studies were reported as: 1)- in USA: 7,000 to 51,247 USD (7,11,12); 2)- in Germany: 4,609 to 49,702 € (6,8,14); 3)- in Spain: 6,559 to 15,174 € (13); 4)- in China 2,148 USD (15). The **median** cost of SE overall in different countries was as follows: 1)- in USA: 8,417 to 33,294 USD (4,7); 2)- in Germany: 4,063 to 32,706 € (5,8,14); 3)- in Australia: 4,787 to 9,932 Australian dollars (10) and 4)- India: 310 USD (9).

Numbers seem to vary in time and between countries. In almost all studies there is enormous variation even within centers. In this respect, length of stay, not surprisingly, looks like the major determinant. In fact, in a previous study investigating ICU hospital costs in patients other than SE, interpatient variability was attributed to length of stay (20). In order to partly overcome this problem, two studies in SE cohorts reported cost/day as 1,458 USD (4) and 3,400 USD (7). Our finding was close to 25-50% of these expenses. Numerous other factors driving health expenditure related to SE have been identified as follows: in-hospital SE detection (13), decreased level of consciousness (13), presence of complications (13), etiology (4,13), increased duration of the episode (9,13), male sex (13), refractoriness of SE (8,11,12,13,14), prolonged length of stay (4,7,8,9) and use of mechanical ventilation (8,9).

Health expenditures in our cohort are closer to western countries, indicating similar reimbursement strategies. Most of our results are in agreement with previous publications. Failure to detect significant effect of SE type (i.e., refractory vs non-refractory) on cost may be due to the small number of patients in our study. In another study, the cost of SRSE was more than five times the cost for NRSE and more than twice the cost of RSE (11). Age has been a controversial issue in the literature. Two studies

Table 4. Status epilepticus related direct costs according to clinical variables

	Cost of VEEGM (USD) median (range)	Cost of ASD (USD) median (range)	Cost of anesthetics (USD) median (range)	Other expenses (USD) median (range)	Total cost (USD) median (range)
Indication of hospitalization					
NCSE	163 (14-3967)	185 (43-993)	25 (0-1509)	9772 (1671-101128)	10111 (2183-101975)
non-NCSE	135 (16-726)	194 (20-1413)	183 (16-504)	14722 (8868-138706)	16320 (9478-140132)
	p=0.845	p=0.486	p=0.151	**p=0.050**	**p=0.034**
GCS					
≤8	175 (16-3967)	250 (46-1413)	115 (5-504)	27238 (1779-138706)	29278 (2282-140132)
>8	127 (14-1397)	146 (20-993)	2 (0-269)	8868 (1671-38180)	9478 (2183-38333)
	p=0.843	p=0.112	**p=0.003**	**p=0.014**	**p=0.011**
STESS					
0-3	207 (14-1294)	147 (20-441)	3 (0-269)	8439 (1671-38180)	8884 (2303-38333)
4-6	135 (16-3967)	224 (46-1413)	96 (0-504)	16029 (1779-138706)	16490 (2183-140132)
	p=0.949	p=0.331	**p=0.031**	**p=0.028**	**p=0.020**
Type of SE					
NRSE	273 (16-1392)	145 (20-793)	4 (0-269)	12583 (1671-82245)	13324 (2183-97495)
RSE/SRSE	82 (14-3967)	239 (24-1413)	115 (0-504)	11205 (1779-138706)	11750 (2282-140132)
	p=0.400	**p=0.031**	**p=0.013**	p=0.603	p=0.425
Whole study group	135 (14-3967) (1.1%)	194 (20-1413) (1.6%)	49 (0-1509) (0.4%)	11246 (1671-138706) (96.9%)	11831 (2183-140132) (100%)

VEEGM: Video-EEG monitoring, ASD: Anti-seizure drugs, USD: US dollars, NCSE: Non-convulsive status epilepticus, GCS: Glasgow Coma scale, STESS: Status epilepticus severity score, NRSE: Non-refractory status epilepticus, RSE: Refractory status epilepticus, SRSE: Super refractory status epilepticus, EEG: Electroencephalogram

reported a "U" shaped effect of age on cost (9,12). Another study, however, reported the opposite with patients in the 17 to 45-year range leading to higher expenditures (4). Other publications failed to detect a significant correlation.

The comparison of cost related to SE with cost in other NICU patients revealed similar results in our study. A previous study compared cost of SE with stroke and reported that SE was more costly, but the difference was not significant (9). Another group compared SE costs with various major acute disorders and decided that SE related costs were higher (4).

To the best of our knowledge, direct costs related to NCSE management was not reported before. We found that expenditures concerning anti-seizure drugs, IV anesthetics and VEEG monitoring constituted only 3% of all critical care expenses. In our health care system, VEEG in the ICU is reimbursed only for the first 24 hours, regardless of the duration of monitoring per session. Health related reimbursement policies may be different in other countries. Interestingly however, in a previous study from the United States, cost for continuous EEG monitoring was not different from routine EEG use in the ICU (21). The authors concluded that "Continuous EEG was favorably associated with inpatient survival in mechanically ventilated patients, without adding significant charges to hospital stay". Continuous EEG constituted only 1% of all hospital expenditures for NICU patients in other studies (21,22). This is very similar to our findings.

The strengths of our study were that all of our patients were prospectively recruited and were followed up with VEEG monitoring in the NICU. We did not use ICD codes to gather patients and did not obtain information from health insurance companies. Our patient population consisted solely of patients with NCSE, which made it more homogenous than several previous investigations. We used the latest definition of SE unlike some older studies.

Study Limitations

Our study also had certain limitations. First of all, this was a single center study with relatively small number of patients. This might be responsible for a lower statistical power, leading to failure in discovering the significant contribution of several parameters, such as SE refractoriness, on the overall hospitalization costs. Second, patients in this study were recruited over a long period of time. We were not able to look at the effect of inflation, which might alter health expenditures over time. Third, we did not look at the timing between SE onset and initiation of treatment. We think this is not easy to do, since it is not possible to know when NCSE develops after a convulsive seizure without EEG recording. Besides, in comatose patients in the ICU, detection of NCSE depends on the time of EEG recording which is usually requested by the neuro-intensivist. Fourth, we did not calculate the effect of underlying etiology, existing co-morbidities and the development of complications on cost. We could indirectly speculate that these parameters were responsible for the great majority of expenditures, given that SE management related direct costs were only 3%. These factors also affect the length of stay, which is a major determinant of cost.

Conclusion

In conclusion, care for patients with NCSE who are followed up in ICUs leads to a significant health care cost. Given the high incidence of SE in the population, overall hospitalization

charges may comprise a significant amount. Most of the health care related expenditures in this cohort are largely determined by non-modifiable factors. Early diagnosis and treatment of SE may improve outcome and decrease health expenditures by decreasing ICU related care and length of stay.

Ethics

Ethics Committee Approval: The study was approved by the Hacettepe University Faculty of Medicine Local Institutional Ethics Committee (approval no: FON 08/19-53, date: 01.05.2008).

Informed Consent: Written informed consent was obtained prior to EEG recording in the study cohort.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Concept: C.A.Ç., O.S., N.D., Design: E.M.A., M.A.T., N.D., Data Collection or Processing: C.A.Ç., O.S., Analysis or Interpretation: C.A.Ç., E.M.A., M.A.T., N.D., Literature Search: C.A.Ç., E.M.A., M.A.T., N.D., Writing: N.D.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: This study was supported by Hacettepe University Research Fund, grant no: 1-801 105 001 (ND) .

References

1. Lv RJ, Wang Q, Cui T, Zhu F, Shao XQ. Status epilepticus-related etiology, incidence and mortality: a meta-analysis. Epilepsy Res 2017;136:12-17.
2. Neligan A, Noyce AJ, Gosavi TD, et al. Change in mortality of generalized convulsive status epilepticus in high-income countries over time: a systematic review and meta-analysis. JAMA Neurol 2019;76:897-905.
3. Kortland LM, Knake S, Rosenow F, Strzelczyk A. Cost of status epilepticus: a systematic review. Seizure 2015;24:17-20.
4. Penberthy LT, Towne A, Garnett LK, Perlin JB, DeLorenzo RJ. Estimating the economic burden of status epilepticus to the health care system. Seizure 2005;14:46-51.
5. Strzelczyk A, Knake S, Oertel WH, Rosenow F, Hamer HM. Inpatient treatment costs of status epilepticus in adults in Germany. Seizure 2013;22:882-885.
6. Strzelczyk A, Nickolay T, Bauer S, et al. Evaluation of health-care utilization among adult patients with epilepsy in Germany. Epilepsy Behav 2012;23:451-457.
7. Beg JM, Anderson TD, Francis K, et al. Burden of illness for super-refractory status epilepticus patients. J Med Econ 2017;20:45-53.
8. Kortland LM, Alfter A, Bähr O, et al. Costs and cost-driving factors for acute treatment of adults with status epilepticus: A multicenter cohort study from Germany. Epilepsia 2016;57:2056-2066.
9. Misra UK, Kalita J, Bhoi SK, Dubey D. Cost of status epilepticus in a tertiary care hospital in India. Seizure 2015;31:94-98.
10. Mitchell RJ, Herkes G, Nikpour A, et al. Examining health service utilization, hospital treatment cost, and mortality of individuals with epilepsy and status epilepticus in New South Wales, Australia 2012-2016. Epilepsy Behav 2018;79:9-16.
11. Sánchez Fernández I, Amengual-Gual M, Barcia Aguilar C, Loddenkemper T. Estimating the cost of status epilepticus admissions in the United States of America using ICD-10 codes. Seizure 2019;71:295-303.
12. Sánchez Fernández I, Loddenkemper T. Estimating the cost of admissions related to convulsive status epilepticus in the United States of America. Seizure 2018;61:186-198.
13. Santamarina E, Parejo B, Abraira L, et al. Cost of status epilepticus (SE): effects of delayed treatment and SE duration. Epilepsy Behav 2018;89:8-14.
14. Strzelczyk A, Ansorge S, Hapfelmeier J, et al. Costs, length of stay, and mortality of super-refractory status epilepticus: a population-based study from Germany. Epilepsia 2017;58:1533-1541.
15. Lu L, Xiong W, Yang X, et al. In-hospital mortality of status epilepticus in China: results from a nationwide survey. Seizure 2020;75:96-100.
16. Leitinger M, Beniczky S, Rohracher A, et al. Salzburg consensus criteria for non-convulsive status epilepticus--approach to clinical application. Epilepsy Behav 2015;49:158-163.
17. Holtkamp M, Othman J, Buchheim K, Meierkord H. Predictors and prognosis of refractory status epilepticus treated in a neurological intensive care unit. J Neurol Neurosurg Psychiatry 2005;76:534-539.
18. Shorvon S, Ferlisi M. The treatment of super-refractory status epilepticus: a critical review of available therapies and a clinical treatment protocol. Brain 2011;134:2802-2818.
19. Rossetti AO, Logroscino G, Milligan TA, et al. Status epilepticus severity score (STESS): a tool to orient early treatment strategy. J Neurol 2008;255:1561-1566.
20. Reid AY, St Germaine-Smith C, Liu M, et al. Development and validation of a case definition for epilepsy for use with administrative health data. Epilepsy Res 2012;102:173-179.
21. Ney JP, van der Goes DN, Nuwer MR, Nelson L, Eccher MA. Continuous and routine EEG in intensive care: utilization and outcomes, United States 2005-2009. Neurology 2013;81:2002-2008.
22. Vespa PM, Nenov V, Nuwer MR. Continuous EEG monitoring in the intensive care unit: early findings and clinical efficacy. J Clin Neurophysiol 1999;16:1-13.