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# Composition and influencing factors of hospitalization expenses for epilepsy patients based on path analysis

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## Abstract

**Objective** This study aimed to understand the composition and influencing factors of epilepsy patients' hospitalization expenses, thus providing a reference for reducing the disease burden of epilepsy patients in low- and middle-income developing countries.

**Methods** A total of 4206 hospitalized cases of epilepsy from 2018 to 2020 were collected. Descriptive statistics were used to understand the patient cost composition, path analysis was used to understand the direct and indirect factors of hospitalization expenses.

**Results** From 2018 to 2020, the average hospitalization expenses for epilepsy patients was 4,299.93 RMB yuan, and the average length of stay was 2.47 days. The highest proportion of hospitalization expenses was diagnosis costs (> 50%), followed by comprehensive medical service costs and drug costs. In terms of the total effect coefficient, the major factors affecting the hospitalization expenses were length of stay (0.880), emergency admission (0.463), and the comorbidities and complications (> 0.250). Hospital length of stay, discharge mode (death) and number of hospitalizations (2 times) affect hospitalization expenses through direct effect. Long-term hospitalization (> 30 days), admission routes (emergency), the comorbidities and complications, presence of drug allergy, and age also affect hospitalization expenses through indirect effects.

**Conclusion** Diagnosis costs and length of stay are important factors affecting the medical expenses of epilepsy inpatients. In general, the quality control of the hospital is good, but it still needs to standardize the diagnosis and treatment behavior of medical staff through the clinical path.

**Keywords** Epilepsy, Hospitalization expenses, Path analysis

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## Introduction

Epilepsy is a neurological disorder with a complex etiology requiring long-term treatment and is characterized by recurrent episodes [1]. The etiology of epilepsy is idiopathic, acquired and cryptogenic [2]. Antiepileptic drugs are the main way of treating epilepsy, which reduce the frequency of seizures by enhancing brain inhibitory function. But more than one third of patients developed resistance to antiepileptic drugs [3], which somehow increased the disease burden of patients.

Long-term medication and hospitalization can place a heavy social and economic burden on patients with epilepsy [4]. According to statistics, the average annual medical expenses of each patient with epilepsy in 2004 were between 909 and 4253 US dollars [5]. Neurological diseases such as stroke, migraine, and epilepsy are the second leading cause of death worldwide [6]. There are 125,000 people in the world dying from epilepsy each year, and about 80% of the deaths occur in low-income countries [7]. In low- and middle-income countries, about 75% of people with epilepsy cannot access the required treatment due to the inability to afford treatment. To improve the accessibility and affordability of patient access to care, the Seventy-third World Health Assembly released the 10-year Action Programme for Epilepsy and Other Neurological Diseases [8].

With the deepening of research, the economic cost of epilepsy patients expanded from direct economic cost to indirect economic cost [9, 10]. The direct economic costs of epilepsy patients mainly include the medical expenses such as using drugs, receiving examinations and receiving treatment. The indirect economic cost refers to

the economic costs that the patient or his family members reduce their working time because of epilepsy [11]. Scholars have long tracked epilepsy patients aged 15 to 69, and found that deaths from epilepsy cost more than \$20 billion in GDP [12]. Related studies in Africa, the United States and Germany showed that the age, sex, education level, seizure frequency, performance of epilepsy surgery, length of disease duration, and the number and location of drugs purchased by patients were closely related to the medical costs of patients with epilepsy [10, 13, 14]. Asia is the largest continent in the world, and one study showed that the incidence of epilepsy is higher in Asian populations than in Western countries [15]. However, the research on medical expenses of epilepsy patients is mainly concentrated in developed countries in Europe and America, and there are few studies in Asian region. Therefore, clarifying the composition and influencing factors of epilepsy patients is beneficial to provide a theoretical basis for the medical insurance cost control in China and other developing countries.

Multiple linear regression is a common method to analyze healthcare cost data. As the extension of multiple linear regression, path analysis can further identify the direct and indirect effects of various influencing factors [16]. This study used path analysis methods to analyze the hospitalization expenses of 4206 epilepsy patients in a large tertiary hospital in Southwest China to provide a reference for reducing patients' disease burdens and medical insurance costs.

## Methods

The data was derived from a large tertiary hospital in the southwestern region. The survey subjects were 4206 epilepsy patients hospitalized in the hospital from January 2018 to December 2020. Inclusion criteria: (1) cases without missing items; (2) hospital length of stay duration  $\geq 1$  day and  $\leq 60$  days; (3) the primary diagnosis at discharge was epilepsy. Exclusion criteria: (1) cases with missing items; (2) cases with hospitalization expenses less than the hundredth percentile 1 or greater than the hundredth percentile 99. The data analysis for this study was conducted in an anonymous manner and did not involve the personal privacy of patients, thus ethical approval was not required.

This study was a retrospective single-center study, due to the availability of data, we chose only the variables of hospital length of stay, hospitalization costs, comorbidities and complications with greater influence on the direct economic costs of epilepsy patients. Referring to other literature [17, 18], we identified the study variables including basic information of patients, treatment characteristics and cost profiles. The coding and assignment of each variable are shown in Table 1. Since complications are an important factor affecting the medical

**Table 1** Variables and assignment

Variable	Code	Assignment
Sex	X1	0=Male, 1=Female
Age	X2	0=<18, 1=18–45, 2=46–65, 3=>65
Drug allergy	X3	0=No, 1=Yes
Insurance	X4	0=No, 1=Yes
Admission route	X5	0=Outpatient, 1=Emergency, 2=Other
Number of hospitalizations	X6	0=One, 1=Two, 2=>Three
Comorbidities and complications	X7	0=Non-CC, 1=CC, 2=MCC
Hospital length of stay	X8	0=<8 days, 1=8–14days, 2=>14 days
long-term hospitalization (>30 days)	X9	0=No, 1=Yes
Discharge method	X10	0=Discharge on doctor's orders, 1=Doctor's order to transfer to another hospital, 2=Die, 3=Other
Lg10 hospitalization expense	Y	---
Lg10 hospital length of stay	Y1	---

expenses of epilepsy patients [19], based on the grouping rules of CHS-DRG version 1.0, the subjects were included in the study according to the discharge main diagnosis code and surgical operation code. The subjects were grouped according to the severity of their comorbidities and complications.

As medical data such as hospitalization expenses and hospitalization days showed a right-skewed trend, frequency and median were used for descriptive analysis, and non-parametric tests were used for univariate analysis. The log-transformed hospitalization expenses were used as the dependent variable, and the statistically significant variables in the univariate analysis were used as independent variables. Multivariate stepwise regression analysis was performed using SPSS 26.0, and then the path analysis model was constructed. For unordered multi-category variables, dummy variables were set for analysis. Path analysis, developed in the 1920s, was an improvement in the method of multiple regression analysis to simultaneously analyze the direct and indirect effects of the effects of multiple independent variables on the dependent variable [20, 21]. In this study, multiple regression analysis was used to construct a path analysis model of hospitalization costs to understand the direct effect of independent variables on hospitalization costs and the indirect effect of independent variables on hospitalization costs through hospitalization days [22]. The effect of independent variables on hospitalization costs is reflected by the total effect coefficient. Direct effect coefficient + indirect effect coefficient = total effect coefficient,  $P < 0.05$  as significant test. Direct diameter coefficient of the independent variable on hospital costs = standardized regression coefficient of the independent variable acting on hospital costs. Indirect diameter coefficient = direct effect coefficient of days acting on hospitalization (standard regression coefficient) \* correlation coefficient between independent variable and hospitalization days [23].

## Results

### Demographic information and univariate analysis

Patient demographic information and univariate analysis are shown in Table 2. There were 4206 patients with epilepsy, including 2319 males (55.14%). The patients ranged between 1 and 93 years old, with a mean age of 28.85 years, and the largest proportion of patients between 18 and 45 years old, accounting for 53.30%; 84.69% did not have insurance; 13.88% had comorbidities and complications. Patients were hospitalized in 1–46 days, with a mean value of 2.87 days, with 90.23% of patients hospitalized within 7 days. The univariate results showed that the eight factors of age, drug allergy, admission route, number of hospitalizations, comorbidities and complications, length of hospitalization, excessive length of

hospitalization and discharge method had a statistically significant impact on hospitalization expenses ( $P < 0.05$ ).

### Composition of hospitalization expenses

The hospitalization expenses of patients in 2018–2020 was between RMB 1162.05–251296.45 yuan, with an average hospitalization expenses of RMB 4299.93 yuan. As shown in Table 3, from the perspective of the average cost structure, diagnostic costs accounted for the highest proportion, which remained above 50% for three years; followed by comprehensive medical service costs and drug costs. From the perspective of the changing trend, the proportion of diagnostic costs has generally shown a downward trend, while the proportion of treatment costs, drug costs, and material costs has generally shown an upward trend, but the changes are not significant.

### Multivariate analysis

Using log-transformed hospitalization expenses as the dependent variable, the age, allergy, log-transformed hospital length of stay, long-term hospitalization and discharge route were used as independent variables to conduct multiple stepwise linear regression analysis, and the model was statistically significant ( $P = 0.008$ ), as shown in Table 4. The goodness-of-fit of the regression model was 0.9025 and the adjusted  $R^2$  was 0.9023, indicating that the above influencing factors could explain 90.23% of the variation in hospitalization expenses. There was no collinearity among the variables ( $VIF < 5$ ).

### Path analysis

First, a correlation analysis was conducted between log-transformed hospital length of stay and the independent variables that were statistically significant in multivariate analysis. A path analysis model was established based on the results of regression analysis and correlation analysis, as shown in Table 5. long-term hospitalization, emergency admission, comorbidities and complications, presence of drug allergy, age had both direct and indirect effect on hospitalization expenses, and discharge method (death), number of hospitalization (2 times) only affected hospitalization expenses through the direct effect. According to the total effect coefficient, hospital length of stay, emergency admission, and comorbidities and complications had the greatest effect on hospitalization expenses.

## Discussion

### Age distribution of epilepsy patients

The age distribution of hospitalized epilepsy patients is mainly young and middle-aged people, with patients under 28 years old accounting for about 30% and patients aged 18–45 years old accounting for 53.30%, showing a trend of younger onset. The results of this study are

**Table 2** General situation and univariate analysis of hospitalized patients with epilepsy (n = 4206)

Variable	Group	Assignment	Number	Proportion(%)	Median cost of hospitalization	Z/H	P
Sex	Male	0	2319	55.14	1549.22	-1.186	0.236
	Female	1	1887	44.86	1530.67		
Age	< 18 years old	0	1197	28.46	1498.08	270.696	<0.001
	18–45 years old	1	2242	53.30	1571.39		
	46–65 years old	2	584	13.88	1628.49		
	> 65 years old	3	183	4.35	7850.08		
Drug allergy	No	0	2264	53.83	1504.82	-10.079	<0.001
	Yes	1	1942	46.17	1593.79		
Insurance	No	0	3562	84.69	1544.32	-1.029	0.304
	Yes	1	644	15.31	1534.59		
Admission route	Outpatient	0	3861	91.80	1515.96	662.155	<0.001
	Emergency	1	318	7.56	9086.82		
	Other	2	27	0.64	1484.72		
Number of hospitalizations	One	0	3496	83.12	1537.08	6.358	0.042
	Two	1	468	11.13	1650.97		
	>=Three	2	242	5.75	1500.72		
Comorbidities and complications	Non-CC	0	3622	86.12	1508.81	567.813	<0.001
	CC	1	412	9.80	6339.90		
	MCC	2	172	4.08	8411.91		
Hospital length of stay	< 8 days	0	3795	90.23	1508.79	1029.194	<0.001
	8–14 days	1	307	7.30	9130.29		
	> 14 days	2	104	2.47	23201.99		
Long-term hospitalization (> 30 days)	No	0	4191	99.64	1541.23	-6.641	<0.001
	Yes	1	15	0.36	94174.24		
Discharge method	Discharge on doctor's orders	0	4183	99.45	1542.43	9.728	0.021
	Doctor's order to transfer to another hospital	1	18	0.43	4147.95		
	Die	2	2	0.05	7773.65		
	Other	3	3	0.07	1483.48		

**Table 3** Analysis of the average hospitalization expenses per visit for patients with epilepsy from 2018 to 2020

Year	2018(n=1582)		2019(n=1480)		2020(n=1144)	
	Cost(RMB yuan)	Proportion(%)	Cost(RMB yuan)	Proportion(%)	Cost(RMB yuan)	Proportion(%)
Comprehensive medical service expenses	456.91	12.45	506.64	11.59	574.85	11.31
Diagnosis expenses	2341.54	63.83	2336.70	53.47	2741.66	53.94
Treatment expenses	103.29	2.82	229.83	5.26	263.28	5.18
Rehabilitation expenses	93.42	2.55	138.25	3.16	144.90	2.85
Medicine expenses	420.24	11.45	415.95	9.52	691.60	13.61
Blood and blood product expenses	1.87	0.05	25.06	0.57	97.68	1.92
material expenses	181.65	4.95	237.19	5.43	380.23	7.48
Other expenses	69.72	1.90	480.17	10.99	188.30	3.70
total	3668.66		4369.79		5082.50	

consistent with the conclusions of other scholars, and the age of onset of epilepsy in Asians is mainly concentrated in childhood and early adulthood [15]. According to the age classification of 15 global neurological diseases, the number of disability-adjusted life years (DALYs) caused by epilepsy is the highest in people aged 5 to 29 years [6].

#### Composition of hospitalization costs for epilepsy patients

The average hospitalization expenses of patients was 4,299.93 yuan, of which diagnosis costs and drug costs accounted for a relatively high proportion. The complexity of epileptic etiology makes imaging examination and gene sequencing an important means to evaluating epileptic lesions [24], which to some extent leads to the increase of diagnostic cost. In addition, epilepsy is

**Table 4** Multiple stepwise linear regression analysis of hospitalization expenses ( $n=4206$ )

Variable	Non-standardized coefficients	Standard deviation	Standardization coefficient	t	P	VIF
(constant)	3.160	0.005	-	596.08	<0.001	-
Hospital length of stay	0.795	0.005	0.880	146.84	<0.001	1.546
Long-term hospitalization	0.432	0.028	0.076	15.28	<0.001	1.059
Admission route (Emergency)	0.074	0.007	0.058	9.95	<0.001	1.439
Discharge method (death)	0.458	0.076	0.029	6.06	<0.001	1.012
Comorbidities and complications(MCC)	0.044	0.009	0.025	4.70	<0.001	1.263
Comorbidities and complications(CC)	0.024	0.006	0.021	3.83	<0.001	1.255
Drug allergy	0.014	0.003	0.021	4.34	0.010	1.026
Age(>65 years old)	0.023	0.009	0.014	2.69	0.007	1.157
Number of hospitalizations(two times)	0.014	0.005	0.013	2.64	0.008	1.022

**Table 5** Path analysis of hospitalization expenses for patients with epilepsy ( $n=4206$ )

Variable	Direct effect	Indirect effect	Total effect	Order	Correlation coefficient with Y2
Hospital length of stay	0.880	-	0.880	1	1.000*
Long-term hospitalization	0.076	0.109	0.185	6	0.124*
Admission route (emergency)	0.058	0.405	0.463	2	0.460*
Discharge method (death)	0.029	-	0.029	8	0.001
Comorbidities and complications(MCC)	0.025	0.237	0.262	4	0.269*
Comorbidities and complications(CC)	0.021	0.264	0.285	3	0.300*
Drug allergy	0.021	0.042	0.063	7	0.048*
Age(> 65 years old)	0.014	0.177	0.191	5	0.201*
Number of hospitalizations(two times)	0.013	-	0.013	9	0.016

\* Represents a significant correlation at level 0.05 (two-tailed)

a medical disease, and about 60% of patients can effectively suppress seizure through antiepileptic drugs [25], so the drug proportion is relatively high in the total cost, which is the second largest hospitalization expense item. However, the drug proportion of hospitalized epilepsy patients from 2018 to 2020 is less than 14%, which is lower than the international average level [26, 27], which may be related to the cancellation of drug markup in China.

#### Rationality of path analysis method

As an extension of multiple regression analysis, path analysis can analyze the influencing factors more scientifically. Only by looking at the results of multiple regression analysis, it can be found that the influence coefficient of ultra-long-term hospitalization ranked second, but after the path analysis, the total effect coefficient of ultra-long-term hospitalization decreased significantly from the second to the sixth. Therefore, it has some limitations to analyze the influencing factors only according to the linear regression results, so it is necessary to comprehensively evaluate the influencing factors by means of path analysis, so as to fully understand the relationship among the variables [28]. According to the total effect coefficient, the top three factors with the biggest impact on hospitalization expenses were hospitalization days (0.880), emergency admission (0.463), and comorbidities and complications (>0.250).

#### Factors influencing hospitalization costs in epilepsy patients

Although the number of hospitalization had the greatest impact on hospitalization expenses, the study results showed that 90.23% of patients stayed within a week, and the average number of hospitalization days was 2.87, which may be related to the reform of health insurance payment method. However, in terms of the median cost, patients with more than 14 hospitalization days spent 14,071.70 yuan more than those who spent less than a week, which prompted us to standardize the diagnosis and treatment procedures to shorten the hospitalization days. It is also necessary to pay attention to the impact of admission routes and comorbidities and complications on medical costs. Patients admitted to the emergency department are more likely to be admitted to the intensive care unit (ICU) due to other medical conditions, which partly leads to increased in medical costs. The severity of comorbidities and complications usually indicates the treatment difficulty of the disease, and patients with complications also consume more medical resources, so the severity of comorbidities and complications is often positively correlated with the hospitalization expenses, which is consistent with the studies of other scholars [29]. Medical costs for epilepsy patients with comorbidities and complications are approximately four times higher than for patients without comorbidities and complications [30]. Appropriate treatment is

a common problem in the management of epilepsy patients in low-income regions of Asia. Although the impact of insurance on hospitalization expenses is not statistically significant, 84.69% of patients had no insurance and paid themselves to pay for medical expenses, which still prompts us to expand the coverage of medical insurance. Although the impact of insurance on hospitalization costs was not statistically significant, 84.69% of patients had no insurance and used out-of-pocket expenses to pay for medical expenses. The average annual out-of-pocket cost is higher in China compared with other countries [31]. This prompts us to expand Medicare coverage so that more people with low-income epilepsy have a chance to get treated properly.

#### **International perspective of hospitalization costs in epilepsy patients**

Unlike other study [32], the results showed that the highest proportion of hospital costs for epilepsy patients was diagnostic costs (more than 50%) rather than drug costs, which may be related to the drug policy implemented in China. From the total effect coefficient, the factors with a greater influence on hospitalization costs are hospitalization days, emergency admission, and complications. A study from Italy showed that 95% of patients with epilepsy were admitted to emergency departments, so screening programs were needed to ensure that patients with epilepsy were treated and managed early, control the development of the disease, and reduce the cost of hospitalization for epilepsy patients [33]. By analyzing the hospitalization data of Australian patients with epilepsy from 2012 to 2016, some scholars pointed out that in order to reduce health expenditure, patients, patients' families and caregivers should be let together to develop comprehensive nursing plans, so as to control seizures, treat complications in time [34].

#### **Other influencing factors of the disease burden in epilepsy patients**

This study confirmed the influence of admission route, comorbidities and complications, and age on hospitalization costs in epilepsy patients. The comorbidities of patients with epilepsy usually include anxiety, depression and so on, and the resulting negative emotions will have adverse effects on the family and social life of the patients [35]. Therefore, in addition to seizure control, we also need to pay attention to the mental health status of epileptic patients. Besides the factors affecting the direct economic costs of epilepsy patients, we also need to consider the influence of mental health, family status, social environment and other factors on the disease burden of diseases in epilepsy patients. Some scholars found that the proportion of epilepsy patients living in the general area of economic development status hospitalized was

higher [34]. Moreover, compared with direct economic costs, some studies have shown that the decline of working hours caused by epilepsy and the loss of indirect economic costs have a greater impact on epilepsy patients and the society [12].

#### **How to control hospitalization costs of epilepsy patients**

The hospitalization cost of patients with epilepsy is mainly diagnosis cost. Relevant departments are aware of this problem, and the Chinese government has been working hard to promote the mutual recognition of examination results between different medical institutions. Although the drug cost is also an important expenditure for epilepsy patients, the study results show that the proportion of drug cost for epilepsy patients is lower than the international level of [26, 27], which is closely related to the long-term efforts of the Chinese government. On the one hand, to control drug prices, China has organized centralized procurement of drugs for common diseases and chronic diseases since 2018, and determined the winning price of drugs through bidding. Since the implementation of the policy, these drugs have been reduced by an average of 50%, reducing the burden on patients to some extent. At present, under the promotion of the Shenzhen Municipal Medical Insurance Bureau, 3,747 designated retail pharmacies have taken the initiative to reduce the prices for 3,319 medical insurance drugs, thus reducing the cost of buying medicine for patients. Another review of studies found that surgical treatment is more cost-effective than drugs alone in the long term [36], so improving the accessibility of surgery in these patients would also reduce patient costs.

#### **Conclusion**

The overall number of hospitalization days and hospitalization expenses of hospitalized patients with epilepsy are controlled within a reasonable range. To further control the medical costs, hospitals need to pay attention to the admission routes and comorbidities and complications related to the severity of the disease, and establish a standardized care process to reduce the disease and economic burden of patients. Combined with other studies, drug costs are also an important expenditure for epilepsy patients. The measures can be taken to improve the scope of medical insurance reimbursement, the unified procurement of some common drugs by health departments, and the establishment of drug price query information system.

#### **Author contributions**

J.G. and G.S. conceived the paper. J.G., S.L. and O.X. collected the data. J.G. drafted the manuscript. N.L., Y.W. revised the manuscript. W.X. and L.S. provided ideas for revising the manuscript. G.S. contributed to the critical revision of the manuscript for important intellectual content and approved the final version of the manuscript. J.G. and G.S. are the study guarantors. All authors have read and agreed to the published version of the manuscript.

### Funding

This research was funded by Philosophy and Social Sciences Planning Project of Guangdong Province in 2023: Research on the mechanism of national voluntary epidemic prevention behavior based on Repast-fsQCA in the context of COVID-19 "Class B and B control", grant number GD23CGL11, Natural Science Foundation of Guangdong Province in 2022: Construction and application of COVID-19 control model PSR-SOR-Haddon in Guangdong Province, grant number 2022A1515011112, and Guangzhou Municipal Science and Technology Program key projects: Research and development of common diseases diagnosis and treatment system for middle-aged and elderly people based on artificial intelligence, grant number 202103000037.

### Data availability

The data comes from a tertiary hospital. The use of data requires obtaining authorization from the hospital.

### Declarations

#### Ethics approval and consent to participate

According to the Measures for Ethical Review of Human Life Science and Medical Research Involving People issued in China in 2023, this study is exempt from ethical review because it uses anonymous information and does not cause harm to human or involve sensitive personal information. Because the data obtained after each patient's written consent to treatment were anonymous, patient consent was not required.

#### Consent for publication

Not applicable.

#### Competing interests

Gang Sun is the editor of the *International Journal for Equity in Health*. And the authors declare that they have no competing interests.

Received: 20 April 2024 / Accepted: 31 July 2024

Published online: 07 August 2024

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