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Hospitalization and post-discharge expenses of stroke in Iran: A retrospective cohort study

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Keywords
Stroke; Hospitalization; Patient Discharge; Economics

Abstract

Background: Stroke claims about 5.5 million lives annually, making it the second leading cause of death worldwide. In the United States (US), it is the fifth leading cause, trailing behind cardiovascular diseases (CVD) and cancer.

Methods: This retrospective cohort study conducted at Valiasr Hospital in Arak City, Iran, focused on patients with stroke registered in Arak University of Medical Sciences. 153 patients were examined. Data on demographics, stroke types, financial items, and National Institutes of Health Stroke Scale (NIHSS), Barthel, and modified Rankin Scale (mRS) scores were collected. NIHSS, mRS, and Barthel scales were used to assess economical findings of hospitalization and the first trimester after discharge in private and governmental health settings. Data were analyzed through SPSS software for statistical analysis.

Results: The study involved patients with a mean age of 69.53 [standard deviation (SD) = 13.4] years, who were hospitalized for about 4.97 days. Gender distribution was with women at 51% and men at 49%. After discharge, a significant majority (66%) received care exclusively from private settings, while 34% utilized both private and governmental services. In contrast, governmental settings showed no significant differences in costs related to NIHSS scores (P = 0.120). Similarly, Barthel scores indicated notable cost disparities in private settings at all stages (P = 0.0001), while governmental settings exhibited no significant differences post-discharge (P = 0.777).

Conclusion: Our study reveals that patients primarily rely on private settings for post-discharge services, with costs largely borne by themselves. The financial burden of hospitalization is mostly covered by basic insurance.

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Introduction

Stroke, with a mortality rate of about 5.5 million people per year, is known as the second cause of death in the world, after cardiovascular causes.[1] Stroke is the fifth leading cause of death in the United States (US), after cardiovascular diseases (CVDs), cancer, chronic respiratory diseases, and accidents.[2] In a study in 2015, it was found that, like in other countries, stroke was one of the most important causes of death in Iran.[3]

Data on the costs of stroke are scarce in low- and middle-income countries (LMICs), but in high-income countries, a mean of 3% of governmental health budgets are spent on stroke costs, which finally, it has a high socio-economic burden on the society, especially on people with medium and low income.[1] Costs caused by stroke include direct costs and indirect costs due to reduced productivity and premature mortality. One of the factors that determine the cost imposed on patients and the health care system is the length of their stay in the hospital. It is possible to think of measures by which after performing the acute phase treatment measures, while the patient will benefit from the necessary comprehensive care, the treatment costs can be reduced by reducing the duration of hospitalization.[2] The right solution to achieve this goal is keeping patients in specialized centers such as nursing homes and increasing the capacity of long-term care facilities.[3] This type of care is a comprehensive and cost-effective care approach that is designed with the aim of improving treatment results in patients who need medical interventions or rehabilitation. These cares can be a suitable alternative for the continuation of the patient's hospitalization after the treatment of the acute stage of the disease.[4,5] Hospital costs are estimated to be between 28% and 83% of the total cost of stroke. These values are largely obtained by calculating the method used for social costs.[6] However, few studies have been conducted in this regard and there is poor information about the costs of hospitalization, treatment, hospitalization, treatment, and rehabilitation. Considering the burden of stroke on the health system and the patient, as well as the high prevalence of the disease and its importance, it is necessary to examine the costs of stroke.[4,7]

As mentioned, most of the existing research is conducted in developed countries, and studies in developing countries are few. The present study was conducted in order to investigate the direct costs caused by stroke during hospitalization and during the first trimester after discharge, and in this research, we seek to answer the question of what costs stroke imposes on the patient and the health system. As a result, by evaluating and discussing in this field, it is possible to provide solutions to reduce the burden of disease and improve the policies and planning of the health system.

Materials and Methods

This retrospective cohort study was carried out in Valiasr Hospital in Arak City, Iran, in 2022. The studied participants included the patients who were registered in the stroke registration program of Arak University of Medical Sciences. Patients who were discharged with personal consent, despite the doctor's recommendation for a longer hospitalization period, and patients who died during hospitalization were excluded from the study. Based on the study by Dey et al.,[8] assuming a type I error (α) of 0.05, a standard deviation (SD) (σ) of 13.855, and a precision (δ) of 2.200, the sample size (n) was calculated according to the formula for estimating a population mean:

$$n = \left(\frac{Z_{1-\frac{\alpha}{2}} \times \sigma}{\delta}\right)^2$$

Data were collected at time point of admission and three months post-discharge, and these were collected from clinical records and patient follow-up. In this study, direct medical expenses related to the stroke, such as hospitalization expenses, drugs, doctor's visits, rehabilitation, as well as non-medical direct expenses, such as travel expenses of patients, in order to receive diagnostic-therapeutic measures, were investigated. And indirect costs, such as the cost of staying away from work, have not been evaluated in patients.[9]

Using the available data in the stroke registration program of Arak University of Medical Sciences, demographic information, type of stroke, severity of stroke based on National Institutes of Health Stroke Scale (NIHSS), level of functional dependence after stroke based on Barthel scale, and degree of disability caused by stroke based on the modified Rankin Scale (mRS) were extracted. Hospitalization costs of the patients were collected using the invoices of the archived files of the patients. These costs included the costs of nursing, counseling, rehabilitation, consumables, visits, drugs, tests, imaging and echocardiography, normal bed, intensive care unit (ICU) bed, monitoring, resuscitation, and surgery. The cost of stroke during the first quarter after

discharge was evaluated using a questionnaire and based on the information of the patient, the patient's companion, and the patient's documents and payment receipts, as well as based on the applications approved and used by the financial department of Valiasr Hospital. These costs included the cost of drugs, rehabilitation treatments, doctor's visits, home care, commuting, echocardiography, portable rhythm monitoring, photography, tests, corrugated mattress, wheelchair and crutches, varicose stockings, supine and sounding, oxygen and suction, nasogastric tube (NGT), and dressing of the patients. The cost of traveling to and from hospital by private vehicle to receive diagnostic-therapeutic services was estimated. Notably, as this was an observational registry-based study, formal blinding of assessors was not feasible. However, assessments were performed independently of cost data collection, which may have helped to reduce bias.

The analysis was conducted by SPSS software (version 16, SPSS Inc., Chicago, IL, USA). Descriptive statistics, including frequency and percentage for categorical variables and mean and SD for continuous variables, were obtained. The Kruskal-Wallis test, a non-parametric method, was applied to compare differences between groups. A P-value < 0.05 was considered to be statistically significant. This test was chosen because the cost data did not follow a normal distribution and exhibited heterogeneity of variances across groups, violating the assumptions required for parametric tests such as analysis of variance (ANOVA). In addition, to account for potential confounding and to model cost determinants, a generalized linear model (GLM) with a log-link function and gamma distribution was employed, as this specification is appropriate for skewed cost data. Covariates were selected based on clinical relevance and prior evidence, including age, gender, stroke type, length of hospitalization, and baseline measures of stroke severity and functional status (NIHSS, Barthel index, and mRS scores). Regression results were expressed as coefficients with 95% confidence intervals (CIs).

Results

The mean age of patients participating in the study was 69.5 (SD = 13.4) years. The mean length of hospitalization was 4.9 days. Women and men were presented in the study (51% and 49%, respectively). The highest frequency of occupational activity in patients was housekeeping (49.7%). Among the types of stroke, the highest frequency was related to ischemic stroke (73.2%). In the current study, 124 patients suffered from ischemic stroke and transient ischemic attack (TIA), and 3 of them received thrombolytic (4.2%). In this study, regarding the services required after discharge, 101 patients (66%) received services only from the private setting and 52 patients (34%) received services from both the private and governmental settings (Table 1). 33% of the patients who received the required services after discharge only from the private setting received services that were only offered to patients privately and the governmental setting did not provide these services, such as medicine, wavy mattress, cane, etc.

Table 1. Demographic findings

Variable	Value
Age (year) (mean ± SD)	69.53 ± 13.39
Hospitalization duration (day) (mean ± SD)	4.97 ± 5.64
Gender [n (%)]	
Men	75 (49.0)
Women	78 (51.0)
Occupation [n (%)]	
Householder	76 (49.7)
Retired	49 (32.0)
Employed/occupied	28 (18.3)
Type of stroke [n (%)]	
Ischemic	112 (73.2)
Hemorrhagic	29 (19.0)
TIA	12 (7.8)
Thrombolytic therapy [n (%)]	
Received	3 (2.4)
Not received	121 (97.6)
After discharge setting [n (%)]	
Private	101 (66.0)
Private and governmental	52 (34.0)

TIA: Transient ischemic attack; SD: Standard deviation

The findings show the mRS, NIHSS, and Barthel scores in the study participants. According to the findings of table 2, the mean (SD) of the mRS score at the time of referral and three months later was 3.71 (SD = 1.47) and 2.22 (SD = 2.07), respectively. The mean (SD) of the NIHSS scores at the time of referral and three months later was 11.60 (SD = 7.41) and 8.01 (SD = 12.82), respectively. The mean (SD) of Barthel scores at the time of visit and three months later was 47.97 (SD = 33.89) and 73.32 (SD = 34.34), respectively. Among the subgroups of the NIHSS scale, the highest frequency was related to the moderate stroke subgroup (58.8%). The highest frequency

among the subgroups of the Barthel scale, at the beginning of the visit, was related to the severe dependency subgroup (36.6%). The highest frequency among the subtypes of the mRS scale was related to the severe disability subtype (41.8%) (Table 2). The costs of the first quarter after the discharge of the patients participating in the study, separately from the private and governmental settings, are shown in figure 1 (all costs in this study are based on euros).

Cost analysis

The expenses of the first trimester after the discharge of the patients participating in the study separately from the private and governmental settings are shown in figures 1 and 2.

According to the findings of this study, it should be mentioned that in the first quarter after discharge, the mean costs in the governmental setting were much lower than the mean costs in the private setting. On the other hand, 98.89% of the total expenses incurred in the first quarter after discharge were related to the private setting; therefore, the private setting has played an essential role in providing services and costs to patients during the first three months after discharge. The costs of the first trimester after discharge in the governmental setting were mainly covered by the basic insurance (65.86%) and in the private setting mainly by the patient himself (76%). Most of the hospitalization expenses of the patients were covered by the basic insurance of the patients (85.51%).

According to the findings of table 3, the mean costs due to stroke are significantly different according to the NIHSS scores at the time of admission, during hospitalization, and during the first three months after discharge in the private setting, while the mean costs of stroke according to NIHSS scores at the time of visit and during the first trimester after discharge in the governmental settings did not have a significant difference (P = 0.120). Bonferroni test showed that the mean cost during hospitalization in patients with minor stroke was significantly lower than that in patients with moderate to severe and severe stroke (P = 0.012 and P = 0.0001, respectively). And the mean cost during the first three months after discharge in the private setting in patients with minor stroke was significantly lower than that in patients with moderate, moderate to severe, and severe stroke (P = 0.016, P = 0.0001, and P = 0.0001, respectively). Accordingly, a higher NIHSS score at admission was associated with higher costs during hospitalization and three months after discharge in the private setting.

According to the findings of table 3, the mean costs due to stroke according to the Barthel score at the time of visit, at the time of hospitalization, and during the first quarter after discharge in the private settings had significant differences (P = 0.0001 and P = 0.0001, respectively). While the mean costs due to stroke according to the Barthel score, during the first quarter after discharge in the governmental settings, did not have a significant difference (P = 0.777).

Table 2. Characteristics of the modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS), and Barthel scale

Scale/subgroup	Admission (mean ± SD)	3 months after discharge (mean ± SD)	n (%)
mRS score	3.71 ± 1.47	2.22 ± 2.07	–
No significant disability	-	-	24 (15.7)
Slight disability	-	-	12 (7.8)
Moderate disability	-	-	12 (7.8)
Moderately severe disability	-	-	41 (26.8)
Severe disability	-	-	64 (41.8)
Dead	-	-	-
NIHSS score	11.60 ± 7.41	8.01 ± 12.82	-
Mild stroke	-	-	24 (15.7)
Moderate stroke	-	-	90 (58.8)
Moderate to severe stroke	-	-	17 (11.1)
Severe stroke	-	-	22 (14.4)
Barthel score	47.97 ± 33.89	73.32 ± 34.34	-
Independence	-	-	21 (13.7)
Slight dependency	-	-	4 (2.6)
Moderate dependency	-	-	27 (17.6)
Severe dependency	-	-	56 (36.6)
Total dependency	-	-	45 (29.4)

mRS: Modified Rankin Scale; NIHSS: National Institutes of Health Stroke Scale; SD: Standard deviation

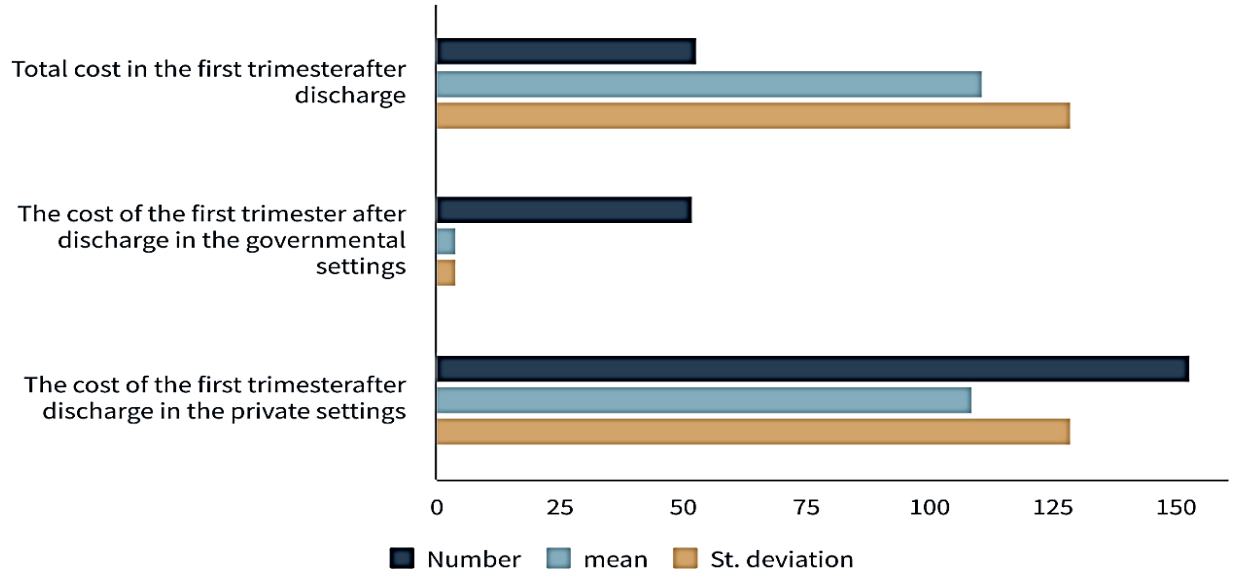

Figure 1. Cost components in the first trimester after discharge

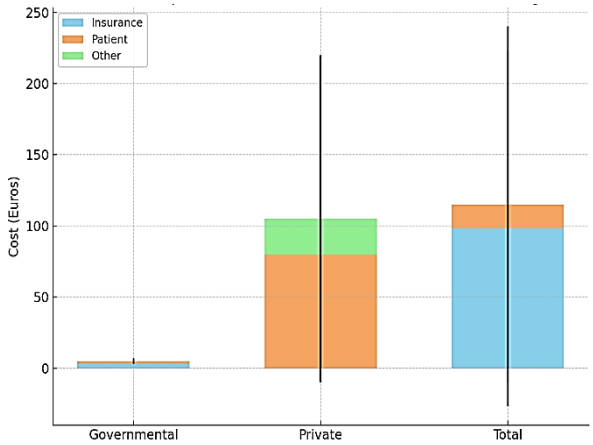

Figure 2. Cost components in the first trimester after discharge

Bonferroni test showed that the mean cost during hospitalization and the first trimester after discharge in the private sector in patients with total dependency was significantly higher than that in patients with independency, slight, moderate, and severe dependency. Therefore, a higher Barthel score at admission was associated with lower costs during hospitalization and three months after discharge in the private setting (Table 3).

Kruskal-Wallis results were further explored with pairwise Mann-Whitney U tests using Bonferroni correction. Adjusted comparisons showed that costs differed significantly between minor and moderate-to-severe strokes (adjusted P = 0.037), minor and severe strokes (adjusted P < 0.001), and moderate and severe strokes (adjusted P = 0.0005). According to the findings of table 3, the mean costs due to stroke according to the mRS score at the time of visit, during hospitalization, and the first trimester after discharge in the private sector were significantly different (P = 0.001 and P = 0.001, respectively), while the mean costs of stroke by mRS score at the time of referral and during the first quarter after discharge in the public sector did not have a significant difference (P = 0.908).

Table 3. The stroke-related costs (during hospitalization and the first quarter after discharge in the governmental and private setting) by Barthel score

Barthel subgroup	Mean hospitalization cost (USD) (mean ± SD)	Cost during first trimester after discharge in governmental settings (USD) (mean ± SD)	Cost during first trimester after discharge in private settings (USD) (mean ± SD)
Total dependency	410.0 ± 110.0	2.1 ± 1.7	190.0 ± 108.0
Severe dependency	195.0 ± 215.0	3.1 ± 3.7	104.0 ± 112.0
Moderate dependency	110.0 ± 45.0	3.6 ± 3.1	62.0 ± 67.0
Slight dependency	91.0 ± 23.0	10.1 ± 12.0	32.0 ± 23.0
Independence	120.0 ± 10.1	34.0 ± 3.1	33.0 ± 19.0
P (Kruskal-Wallis)	0.001	0.777	0.001

SD: Standard deviation

Bonferroni test showed that the mean costs during hospitalization and the first trimester after discharge in the private sector in patients with mRS = 5 were significantly higher than in patients with mRS score of 1, 2, 3, and 4 (P = 0.001, P = 0.026, P = 0.001, P = 0.004, P = 0.001, P = 0.001, P = 0.001, and P = 0.003, respectively). Therefore, a higher mRS score at admission, indicating greater disability, was associated with higher costs during hospitalization and three months after discharge in the private settings.

Length of stay was strongly associated with increased cost: each additional day in the hospital corresponded to approximately 12.5% higher cost [exp(coef) = 1.125, P < 0.001]. Baseline stroke severity, measured by the NIHSS score, was also associated with higher cost, with each additional point corresponding to a 1.6% increase [exp(coef) = 1.016, P = 0.009]. Stroke type had a substantial effect: patients with hemorrhagic stroke incurred significantly higher costs compared to those with TIA, the reference group [exp(coef) = 1.756, P = 0.002].

Discussion

In the present study, the findings have shown that the mean (SD) age of the participating patients was 69.53 (13.39) and the gender distribution of the patients was near-equal. Regarding these demographic findings in similar studies, different results have been obtained. Moreover, it has been stated in various studies that the majority of strokes occur in elderly patients. In epidemiological studies, it has been stated that the mean age of stroke is 69.2 years, which has decreased significantly in recent years.[10] In other words, although the mean age of stroke is still mentioned in the range of elderly people, it has decreased with a slow slope. This issue indicates that strokes in younger patients have a greater potential for lifelong disability, and some of the potential factors identified for this process are modifiable.[11] In addition, it has been stated in another study that the incidence of stroke increases rapidly with age and doubles every decade after age 55; accordingly, most strokes occur at the age of 55 and older.[12]

Stroke costs by functional status (mRS)

In the current study, in evaluating the changes in mRS mean scores three months after the stroke, the results showed that the mean scores in all mRS subgroups decreased significantly (P < 0.050). This issue can point to the effective role of rehabilitation in this field. In addition, in our study, the findings have shown that the mean costs of stroke are significantly different according to the mRS score at admission, during hospitalization, and in the first trimester after discharge in the private setting (P = 0.001 and P = 0.001, respectively), while the mean costs of stroke by mRS score at the time of referral and during the first trimester after discharge in the governmental setting did not have a significant difference (P = 0.908). This issue (similar to the NIHSS scale) can be justified, as in the present study, after discharge, patients have received limited services including doctor's visit, echocardiography, electrocardiogram (ECG), and imaging from the government setting. While the receipt of these services in patients with stroke does not differ based on their level of disability, and services such as rehabilitation, wavy mattress, and nursing at home, the need for which varies based on the patient's level of disability, have not been received from the governmental setting. Regarding the mean costs of stroke during hospitalization and three months after discharge in the private setting, our study showed that a higher mRS score at admission, indicating greater disability, had a positive correlation with higher costs during hospitalization and three months after discharge in the private setting. In a similar study in 1999 on the importance of disability in stroke, it is stated that more disability is associated with higher maintenance and rehabilitation costs of patients.[13] The results of Mu et al.'s study also demonstrated that ischemic stroke in patients with more disability was associated with higher hospitalization costs,[14] which also confirms our findings.

Functional recovery and rehabilitation outcomes (Barthel index)

In the present study, the mean Barthel scores three months after the stroke, in all subgroups of the Barthel scale, increased significantly (P < 0.050) (except for the independence group, which did not change). This finding indicates that three months after the occurrence of a stroke, the patients' functional status has relatively improved; this article can show the effective role of rehabilitation in patients with stroke. The mean costs of stroke, according to the Barthel score at the time of admission, at the time of hospitalization, and three months after discharge in the private setting are significantly different. While in the case of mean costs due to stroke according to the Barthel score, there was no significant difference between them at the first visit and in three months after discharge

in the governmental setting (P = 0.777). In justification of this issue (similar to the NIHSS and mRS scales), it can be said that in our study, after discharge, patients received limited services including doctor's visits, echocardiography, echocardiography (ECG), and imaging from the governmental setting that these services are received similarly in patients with stroke with different levels of functional dependence, and services such as rehabilitation and nursing at home, the need for which is different based on the functional dependence of the patient, have not been received from the governmental setting. The results of the present study have shown that high levels of the Barthel score, or in other words, a better functional level of the patient at the beginning of the visit, are associated with lower costs during hospitalization and at three months after discharge in the private setting. In this regard, a 2001 study examined the findings of two multinational trials regarding the costs of ischemic stroke. This study reported that the Barthel index was the strongest predictor of stroke costs. Other main predictive factors in this study included type of stroke, country of residence, and congestive heart failure (CHF) in the patients.[15] A study was conducted in 2020 in the Czech Republic with the aim of investigating the relationship between the primary disability of patients with stroke and the costs caused by this disease in 87 patients. In this study, it was stated that with the increase in the level of functional dependence of patients, the duration of hospitalization of patients in the rehabilitation department and the resulting costs increased.[16]

Implications for health policy

In LMICs, financial and structural barriers often limit the effective incorporation of advanced stroke therapies. Short-term treatment of severe strokes can be particularly challenging due to inadequate infrastructure in ICUs, limited resources, and lack of specialized training. To address these challenges, a broad and holistic approach is necessary, including developing clinical protocols adapted to local realities, ensuring the employment of cost-effective interventions, and the financial sustainability of health systems. Innovative solutions, such as the use of wearables and artificial intelligence (AI), are leading the way in improving clinical monitoring of patients in regions with limited resources.[17,18]

Furthermore, the relationship between hospital cost and quality of care is complex. Studies have shown that while higher costs may be associated with better quality in some contexts, this is not universally true. In fact, reducing costs without compromising quality requires careful consideration of resource allocation and efficiency.[19]

Strategic planning for stroke care

Effective stroke care planning in resource-constrained settings necessitates a multifaceted approach. This includes prioritizing cost-effective interventions, optimizing resource utilization, and ensuring equitable access to care. Additionally, addressing barriers to medication adherence, such as affordability and healthcare system coordination, is crucial for improving patient outcomes.[20]

Limitations: This study has several important limitations that should be considered when interpreting the findings. First, the use of a single-center, convenience sample (n = 153) may limit the generalizability of the results to other healthcare settings or patient populations. External validity is somewhat limited due to the single-center design and exclusion of certain patient groups. In addition, the lack of evaluation of indirect costs may lead to an underestimation of the overall societal burden. Second, patients who experienced early in-hospital mortality or were discharged against medical advice were excluded, introducing potential selection bias and likely over-representing individuals with relatively better prognoses. Third, although validated functional measures (NIHSS, mRS, Barthel index) were used, assessments were conducted by clinicians involved in routine care without blinding, which may introduce observer bias. Fourth, only direct medical and non-medical costs were included; indirect costs such as lost productivity, caregiver burden, and long-term disability-related expenses were not captured, possibly underestimating the overall societal cost of stroke. Fifth, some component-level cost fields were partially missing, and complete-case analyses were used for multivariable modeling, which may affect estimates of cost distribution across subgroups. Sixth, although multivariable models were applied to control for confounding, residual confounding from unmeasured factors (pre-existing disability, incomplete comorbidity data) cannot be excluded. Finally, the sample size, while adequate for detecting moderate differences in cost across severity groups, remains relatively modest, which may limit statistical power for subgroup analyses and precision of effect estimates.

Conclusion

Our findings indicated that patients received most of the after discharge services they need from the private settings. The costs of the first trimester after discharge in the governmental setting are mainly covered by the basic insurance and in the private setting, mainly by the patient himself. Most of the hospitalization expenses of the patients are covered by the basic insurance of the patients. The increase in the severity of stroke, disability, and functional dependence of patients is associated with an increase in costs during hospitalization and at three months after discharge of patients in the private setting. Evaluating the costs caused by stroke during hospitalization and after discharge can play an essential and helpful role in the planning and policies of the health system.

Conflict of Interests

The authors declare no conflict of interest in this study.

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