Direct Medical Cost for Acute Ischemic Stroke Patients in Vietnam

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Abstract

Ischemic stroke is one of the leading causes of global disease burden. Vietnam, among other low- and middle-income countries, bears nearly 90% of the ischemic stroke burden. This study was a cost-of-illness study conducted from the healthcare system perspective to estimate the direct medical costs and associated factors for acute ischemic stroke patients at Bach Mai Hospital, a major hospital in Hanoi, Vietnam. A total of 500 eligible patients with acute ischemic stroke at the Neurology Department of Bach Mai Hospital from July 2021 to December 2021 were included. Patient characteristics and treatment information were collected via medical records and patient interviews. The majority of the patients were men (65.8%), with a mean age of 65.3 years. The average direct medical cost per patient was 10.5 ± 7.3 million Vietnam Dong (~454.2 ± 313.8 US dollars. Factors significantly associated with higher direct medical costs were the duration of stay, stroke severity, complications, number of comorbidities, and intravenous thrombolysis treatment. The study highlighted the need for a reduction in the duration of hospital stay and an improvement in onset-to-hospital arrival time.

Keywords

Acute ischemic stroke; cost of illness; direct medical cost

Introduction

Stroke is one of the leading causes of mortality and disability globally after cardiovascular diseases and cancers. Ischemic stroke (IS) is the most common type of stroke, and according to the Global Burden of Diseases study in 2019, IS accounted for 7.6 million incidences, which is more than 60% of all new stroke cases and caused 3.3 million deaths (Feigin et al., 2021). Nearly 90% of the stroke burden is borne by low- and middle-income countries (LMICs) (Feigin et al., 2021). Vietnam, among other LMICs, is no exception, as the number of stroke patients is increasing (Công, 2007). The incidence of stroke in Vietnam is 161 per 100,000 people, which is higher than the global incidence of stroke globally (150.8 per 100,000 people) (Feigin et al., 2021). Stroke is one of the leading causes of mortality in Vietnam. According to a 2016 report, the mortality rate due to stroke in Vietnam was 15.5%, which was 1.3% higher than that in 2005 (Carr et al., 2018).

Apart from the burden of stroke from premature deaths, the financial burden of stroke is also enormous; however, the existing economic burden evidence from LMICs is still minimal (Strilciuc et al., 2021). In Vietnam, some studies have been conducted to provide evidence on the treatment costs of patients with stroke. The average total treatment cost for a stroke episode varied from 422 (Le et al., 2016) to USD 1,265 (Pham, 2015) (adjusted to 2022 price). Of the total treatment costs, direct medical costs constitute approximately 66% (Le et al., 2016; Pham, 2015). As for IS, the average treatment cost per patient was estimated at USD 606 (Nguyen & Vo, 2021) and USD 1,147 (Pham, 2015), and these costs could vary from USD 240 to 5,511 (Nguyen & Vo, 2021). The factors associated with the treatment cost of stroke were the duration of hospital stay, the severity of the stroke, old age, type of stroke, choice of treatment, and comorbidity (Le et al., 2016; Nguyen & Vo, 2021; Pham, 2015). Vietnam is entering the aging phase, where the older population is expected to increase (United Nations Fund for Population Activities [UNFPA], 2011), posing a challenge to managing the stroke burden on the Vietnamese healthcare system, societies, and patients.

This study was conducted to further contribute to the existing literature on the economic burden of IS and its associated factors. This study aims to estimate the direct medical cost for IS inpatient treatment and more importantly, identify the factors related to the total inpatient treatment cost of IS patients from the Neurology Department of Bach Mai Hospital in 2021.

Methods

Patient population

Bach Mai Hospital, located in Hanoi, the capital of Vietnam, is one of Vietnam's leading stroke care units. This retrospective study was based on the medical records of all patients with acute ischemic stroke (AIS) admitted to the Neurology Department of Bach Mai Hospital from July 2021 to December 2021. The eligibility criteria were sudden disease onset, clinical symptoms indicating neurological disabilities within 24 hours, and confirmed IS with computed tomography (CT) and magnetic resonance imaging (MRI). We excluded patients who ended their treatment prematurely, had mental retardation, were deaf or mute, were transferred from another hospital, had another type of stroke, or had other neurological diseases.

The study was approved by the Institutional Ethics Committee at Hanoi Medical University and the Bach Mai Hospital Director Board (Decision No. 1407/QĐ-ĐHYHN).

Data collection

This is a cost-of-illness study from the perspective of health service payers in Vietnam. Data collection was conducted by clinicians at the Neurology Department of Bach Mai Hospital.

The following information on eligible patients was collected via medical records and interviews: age, sex, admission unit (emergency/clinical examination unit), time and date of admission, duration of stay, cause of stroke, risk factors of stroke (e.g., high blood pressure, diabetes, smoking, drinking, etc.), comorbidities, National Institute of Health Stroke Scale (NIHSS) score (at admission) (Powers et al., 2019), modified Rankin Scale (mRS) (at discharge) (van Swieten et al., 1988), an adverse event during admission, treatment method (intravenous thrombolysis, mechanical thrombectomy, or medications only), and status at discharge (i.e., recovered, improved, worse, transfer, dead).

Direct medical cost information was collected using hospital medical bills at discharge, which contain all resource utilization during the patient's hospitalization, such as health services (e.g., diagnostic tests, laboratory tests, surgical interventions, etc.), medications, and medical supplies used; number of bed days, as well as insurance status (i.e., insurance coverage status and coverage rate).

Statistical analysis

The cost data collected were in Vietnam Dong (VND) and were also displayed in US dollars (USD) using the 2021 official exchange rate published by the World Bank (2022) (VND 23,159 = USD 1).

Statistical analyses were performed using IBM® SPSS® Statistics (Version 20.0). A descriptive analysis was performed for patients' baseline characteristics, admission information, and treatment outcomes. Mean, standard deviation, median, 25th percentile, 75th percentile, and minimum and maximum values were reported for direct medical cost variables.

Direct medical costs were stratified by patient baseline characteristics, information at admission, cause of stroke, treatment methods, and treatment outcomes and compared using Mann-Whitney's test for two-group means and Kruskal-Wallis's test for comparing multiple-group means. Univariate and multivariate analyses were performed to explore the factors associated with the direct medical costs of IS hospitalization. The p value < .05 was considered statistically significant.

Results

Patient baseline characteristics

A total of 500 eligible patients with AIS from the Neurology Department, Bach Mai Hospital, from July 01, 2021, to December 31, 2021, were included in the study. The baseline characteristics of the eligible patients are presented in Table 1.

Table 1: Patient Baseline Characteristics and Hospital Admission Information

Patient baseline characteristic and admission	*n*	%
Sex		
Men	329	65.8
Women	171	34.2
Health insurance coverage		
Yes	445	89.0
No	55	11.0
Stroke risk factors		
No risk factors	56	11.2
High blood pressure	382	76.4
Diabetes	137	27.4
Drinking	28	5.6
Smoking	10	2.0
Atrial fibrillation	19	3.8
Dyslipidemia	84	16.8
Others*	46	9.2
Admission unit		
Emergency unit	289	57.8
Clinical examination unit	211	42.2
Admission time since onset of symptoms		
Less than 24 hours	184	36.8
More than 24 hours	316	63.2
Cause of stroke		
Atherosclerosis of large arteries	129	25.8
Small vessel diseases	178	35.6
Cerebral embolism	11	2.2
Other causes and unidentified cause	182	36.4
NIHSS score at admission		
0–4	169	33.8
5–15	277	55.4
16–20	31	6.2
21–42	23	4.6

*Note: SD = Standard deviation; NIHSS = National Institute of Health Stroke Scale; *Others: Transient ischemic attack and non-fibrillation cardiovascular diseases.*

The majority of the patients were men (65.8%). The average age of the included patients was 65.3 (*SD* = 12.5), with the youngest being 16 years old and the oldest being 90 years old. Most of the patients had health insurance coverage. Nearly 90% of the patients have at least one

stroke risk factor, and the most common risk factors are high blood pressure and diabetes. Patients were admitted quite late, with 63.2% being admitted more than 24 hours after the onset of symptoms, and the mean admission time was 72.9 hours (*SD* = 86.7). The proportion of emergency admissions was 57.8%, higher than that in the clinical examination unit. Stroke severity at admission was assessed to be mild to moderate, with a mean NIHSS score of 7.9 (*SD* = 5.9), and more than 80% of patients had less than 15 on the NIHSS scale (Powers et al., 2019).

Table 2 summarizes the patients' treatment information and treatment outcomes at discharge.

Table 2: Treatment Patterns and Outcomes

Treatment and outcomes	*n*	%
Treatment methods (n, %)		
Intravenous thrombolysis, mechanical thrombectomy, and/or surgical intervention	6	1.2
Medications only	494	98.8
Duration of stay (Mean, *SD* or *n*, %)		
Mean, *SD* (days)	9.9 (5.2)	
< 7 days	124	24.8
7–14 days	294	58.8
> 14 days	82	16.4
Status at discharge (n, %)		
Recovered	8	1.6
Improved	407	81.4
Worse	9	1.8
Transferred	69	13.8
Dead	7	1.4
mRS score at discharge (Mean, SD, or n, %)		
Mean, *SD* (score)	2.1 (1.6)	
0–1	226	45.2
2	73	14.6
3	78	15.6
4	85	17
5–6	38	7.6

Note: SD = Standard deviation; mRS = Modified Rankin Scale.

The mean hospitalization duration was 9.9 days (*SD* = 5.2). Most patients were treated using only medications (other than intravenous thrombolysis); only six patients were treated with intravenous thrombolysis, mechanical thrombectomy, and surgical intervention. At discharge, 81.4% of the patients were assessed as having an improved status upon admission, and 1.4% of patients died.

Overall, the severity of neurological disabilities in these patients was slight. The mean mRS score at discharge was 2.1 (*SD* =1.6), 45.1% of patients had a 0-1 mRS score (no disability or no significant disability), and 7.6% had severe disability or death.

Direct medical costs

The study finds that the mean direct medical cost per AIS patient was USD 454.2. More details about each direct medical cost can be found in Table 3.

Table 3: Direct Medical Cost Per AIS Patient (in 2021 US Dollars)

Direct medical cost	Mean	Standard deviation	Median	25th–75th percentile
Hospital bed	157.3	128.7	109.8	78.4–187.0
Laboratory test	49.6	79.3	20.8	11.9–43.7
Diagnostic imaging	57.2	53.8	59.4	7.7–82.0
Functional exploration	18.6	8.7	21.1	19.2–21.1
Medication and infusion fluids	122.6	131.1	80.2	51.1–141.2
Blood infusion	1.0	10.9	0.0	0.0–0.0
Surgical interventions	12.7	29.1	6.9	3.9–8.4
Medical supplies	5.1	3.3	4.1	2.9–6.3
Nutritional pathology	30.1	36.8	16.5	0.0–44.8
Total direct medical cost	**454.2**	**313.8**	**339.4**	**249.7–553.0**

Factors related to the direct medical cost of IS inpatient treatment

Univariate analysis results showed that higher direct medical costs for IS patients were associated with a higher NIHSS score at admission, being admitted to the emergency unit, having a longer hospitalization duration, having intravenous thrombolysis, thrombectomy or surgery complications, being worse/transferred/dead at discharge, and having a higher mRS score (Table 4).

Table 4: Univariate Analysis of Direct Medical Cost (in USD 2021) for Ischemic Stroke Patients in Vietnam

Variable	Mean (*SD*)	Median	*p* value
NIHSS score at admission			
0–4	355.6 (219.3)	285.9	< .001 Kruskal-Wallis
5–15	458.4 (310.5)	353.0	
16–20	617.1 (350.8)	545.8	
21–42	909.1 (401.3)	752.3	
Admission unit			
Emergency unit	499.2 (350.4)	359.7	.001 Mann-Whitney
Clinical examination unit	392.5 (242.9)	307.9	
Admission time since onset of symptoms			
Less than 24 hours	441.1 (315.4)	333.6	.47 Mann-Whitney
More than 24 hours	461.9 (313.2)	341.2	
Stroke risk factors			
No risk factors	493.8 (366.9)	357.2	.64 Mann-Whitney
At least one risk factor	449.2 (306.6)	338.9	
Duration of stay			
< 7 days	264 (137.7)	244.1	< .001

Variable	Mean (*SD*)	Median	*p* value
7–14 days	414.4 (230.1)	349.5	Kruskal-
> 14 days	884.5 (371.5)	827.3	Wallis
Treatment methods			
Intravenous thrombolysis, mechanical thrombectomy, and/or surgical intervention	1047.6 (401.2)	105.8	.002 Mann-Whitney
Medications only	447.0 (306.1)	338.9	
Complications			
No complications	387.5 (236.8)	307.7	< .001
Pneumonia	835.1 (426.1)	726.5	Kruskal-
Other complications	500.0 (283.9)	386.8	Wallis
Status at discharge			
Recovered	423.2 (182.2)	401.0	
Improved	420.9 (296.5)	309.1	< .001
Worse	760.7 (450.7)	577.1	Kruskal-
Transferred	611.5 (350.1)	541.5	Wallis
Dead	484.7 (201.4)	587.7	
mRS score at discharge			
0–1	356.4 (289.7)	208.9	
2	441.0 (329.6)	311.5	< .001
3	411.6 (331.9)	247.6	Kruskal-
4	647.0 (483.0)	408.0	Wallis
5–6	717.8 (602.8)	386.6	

Note: NIHSS = National Institute of Health Stroke Scale, mRS = modified Rankin Scale.

Direct medical treatment cost per patient most noticeably increased with NIHSS score at admission (USD 909.1 for patients scored 21–42 compared to USD 355.6 for patients scored 0–4 on NIHSS scale, $p < .001$); Duration of stay more than 14 days (USD 884.5 compared to USD 264 for hospital stay less than seven days, $p < .001$); Had intravenous thrombolysis/thrombectomy/surgical treatment compared to medications only (USD 1,047.6 compared to USD 447.0, $p = .002$).

Multivariate analysis of patient characteristics at admission, during treatment, and at discharge showed that duration of stay, NIHSS score, complications, and comorbidities were significantly associated with higher direct medical costs of AIS patients while using only medication treatment (other than intravenous thrombolysis) was a significant predictor of lower direct medical costs (Table 5). Our model had moderate predictive power, explaining 53.4% of the variation in direct medical costs per patient with IS ($R^2 = 0.534$).

Table 5: Multivariate analysis of direct medical cost for ischemic stroke patients

Variable	Coefficient (β)	*p* value
Constant*	7.164	< .001
Age	0.004	.83
Sex	-0.002	.89
Residence area	0.022	.24
Occupation	0.002	.79
Education level	0.004	.83
Admission unit	-0.003	.86

Variable	Coefficient (β)	*p* value
Health insurance coverage rate	-0.007	.30
Time of admission	0.021	.23
Number of admissions	-0.021	.15
Duration of stay*	0.209	< .001
Cause of stroke	0.010	.12
Stroke risk factors	-0.027	.28
NIHSS score*	0.048	.002
mRS score	0.007	.41
Complications*	0.086	< .001
Number of comorbidities*	0.034	.02
Stroke treatment option*	-0.404	< .001
Status at discharge	0.008	0.47
$R^2 = 0.534$		

*Note: NIHSS = National Institute of Health Stroke Scale; mRS= modified Rankin Scale; *Statistically significant (p < .05)*

Discussion

This study contributes additional evidence on the economic burden of acute ischemic stroke (AIS) and explores the factors associated with direct medical costs for AIS treatment in Vietnam. This study analyzed the treatment costs of 500 AIS patients at the Neurology Department of Bach Mai Hospital. Overall, the mean cost per patient was USD 454.2. Hospital beds, medication and infusion fluid, and diagnostic imaging costs constituted most of the total.

Our findings on the direct medical cost of AIS patients are higher than previous studies conducted in Vietnam. In a study conducted at 115 People's Hospital, a Class I hospital in Ho Chi Minh City, southern Vietnam, the average treatment cost for IS hospitalization was about USD 332.5 (Ngo et al., 2012) (in 2021 currency value). The sample characteristics were similar to our study's: the mean age was 62.6 years old, and 56.1% was male; however, about 2/3 of the sample had mRS of 3–4 at discharge (compared to 1/3 in our study). Despite a higher mRS score at discharge, the average direct medical cost estimate was lower than our study's. At Gia Dinh People's Hospital, another Class I hospital in Ho Chi Minh City, the mean direct medical cost for AIS patients was USD 665.9 (Pham, 2015) and USD 581.7 (Nguyen & Vo, 2021) in two studies in 2015 and 2021. These estimates were significantly higher than our findings; however, these estimates included AIS patients treated with intravenous thrombolysis and surgical, while in our study, only 6 of 500 patients were treated with intravenous thrombolysis treatment, and the cost for intravenous thrombolysis treatment was much higher than medications only, at USD 1048.6. If we look at their reported direct medical cost for patients who did not take intravenous thrombolysis treatment and mechanical intervention, the cost would be USD 226.7 (Nguyen & Vo, 2021) and USD 411.3 (Pham, 2015), which were lower than our results, similarly to the results at 115 People's Hospital. Also, 115 People's Hospital and Gia Dinh People's Hospital are Class I hospitals, which generally have lower health services fees than Bach Mai Hospital, a specially-classed hospital with the highest health care facilities in Vietnam. For example, according to the Vietnam Ministry of Health, regarding the health service fees at public healthcare facilities, the cost for an ICU bed at Specially-class hospitals is 7% higher than Class I hospitals and 40% higher than Class II hospitals.

Furthermore, the specially-classed hospital usually received more severe cases, referred from lower-classed hospitals (e.g., Class I hospitals). Moreover, the patients at Gia Dinh's People Hospital had a shorter duration of stay, a mean of 5.8 days (Pham, 2015), compared to a mean of 9.9 days in our study. The duration of stay is directly related to total hospital bed costs, the most significant component of direct medical costs in the studies (Ngo et al., 2012; Pham, 2015). The distributions of direct medical costs between different cost categories are slightly different among the studies. In studies conducted at Class I hospitals, hospital bed costs accounted for 12.8% (Nguyen & Vo, 2021) to 30.2% (Ngo et al., 2012), followed by cost for subclinical services (e.g., diagnostic imaging, lab testing), accounting for 23.7% (Nguyen & Vo, 2021) to 42.3% (Ngo et al., 2012) of total cost.

Direct medical costs for AIS patients in Vietnam are lower compared with other Asian countries. In one study analyzing health insurance data of nearly 372,000 stroke patients in urban areas of China from 2013-2016, on average, the annual direct medical cost was USD 1,592 per IS inpatient visit or USD 1,163 (converted to 2021 price value) per inpatient visit if we exclude the patient's out-of-pocket costs (Zhang et al., 2019). The stroke patients included in the study had relatively similar characteristics to our research, as the majority of them were men and older. Compared to the findings in Thailand, which has nearly two times GDP per capita higher than Vietnam (World Bank, 2024) with similar sample characteristics in terms of age and gender, the direct medical cost from a healthcare provider perspective was estimated to be USD 2,473 (Sribundit et al., 2017) in the study (converted to 2021 currency value). In this study, the authors included pharmacy service and rehabilitation costs, which we did not have in our research. However, these two items only accounted for a small fraction of total direct medical cost (0.8% and 1.2%, respectively) (Sribundit et al., 2017). They may not be the driver for the higher total direct medical cost compared to our country's findings. Even though the studies did not report comparable information about the patient's characteristics, such as the severity of stroke, we believe that the health service costs in urban China and Thailand would generally be higher than in Vietnam, as the GDP per capita in China (USD 12,617) was more than three times higher and in Thailand (USD 7,060.9) was nearly two times higher than GDP per capita in Vietnam (USD 3,756.5) (World Bank, 2024). This strong positive correlation between income (GDP per capita) and healthcare expenditure has been discussed rigorously (Raghupathi & Raghupathi, 2020; Xu et al., 2011).

A multivariate regression analysis was performed to further understand the factors associated with higher direct medical costs. Our logistic regression model explained 53.4% of the variation in the total direct medical costs. The duration of stay was directly associated with hospital bed costs and was a statistically significant factor that predicted higher treatment costs among AIS patients. This finding is consistent with existing literature (Chow et al., 2010; Nguyen & Vo, 2021). In general, a more extended stay was observed in this study. Our patients had an average stay of 9.9 ± 5.2 days, and the proportion of patients who had more than seven days stay was 75%, whereas the average length of stay was 5.7 days for IS patients in a study in Thailand. In other studies, the authors reported an average duration of stay of nine days; however, the length of stay for rehabilitation was included (Abdo et al., 2018; Zhang et al., 2019).

Our findings further highlight the need to reduce onset-to-treatment time among AIS patients in Vietnam, which could subsequently improve stroke treatment outcomes and reduce stroke burden. Stroke severity at admission is associated with higher total direct medical costs, and delayed hospital arrival may result in more severe stroke conditions and limit effective treatment options. These factors heavily depend on the hospital arrival time since the onset of symptoms. The proven effective intravenous tissue plasminogen activator (IV-tPA), one of the

most recommended stroke treatments to be used, is only eligible within 4.5 hours, or mechanical thrombectomy eligible within 24 hours of symptom onset (Ashraf et al., 2015; Lee et al., 2021). Despite the key to minimizing the damage of AIS is management within the treatment time window of 4.5 hours since the onset of stroke symptoms (Powers et al., 2019), the mean admission time since the onset of our patients was 72.9 hours and more than 60% of our patients were admitted after at least 24 hours since the first signs of stroke symptoms. Compared to other countries, our stroke patients recorded a significantly longer time interval from onset to hospital arrival. In the United States, a large-scale study analyzed 413,000 IS patients and reported that only 3% of the patients presented at the hospital after 24 hours (Tong et al., 2012). Another study in China reported that the median time-to-hospital recorded for IS patients was 8 hours, with 51.9% arriving less than 6 hours after symptoms onset (Fang et al., 2011). In Japan, 36.1% of patients arrived at the hospital within 6 hours of stroke onset, and one-third of the patients arrived within 24 hours (Matsuo et al., 2017).

Costs for AIS treatment are an economic burden, catastrophic even, for Vietnamese patients. Based on the General Statistics Office (2022), Vietnam's household income and expenditure report, total annual household income was estimated to be around VND 241.5 million (about USD 10,616.5). The United Nations defined catastrophic cost for health care as the total cost of healthcare exceeding 10% of total annual household income; however, in some studies, this threshold can be defined as up to 20% of household income (Stracker et al., 2019; Verguet et al., 2017). The AIS treatment cost reported in our study and other studies in Vietnam reported an average direct medical cost per occurrence ranging from USD 332 to 572 (Ngo et al., 2012; Nguyen & Vo, 2021), and in the Pham et al. (2015) study, the total cost for a stroke occurrence (including direct medical cost, direct non-medical cost, and indirect cost) could range from USD 572 to 1,366, indicating that IS can lead to catastrophic healthcare costs, especially for patients who do not have health insurance (11% of the patients did not have health insurance in our study and would have to pay all of the direct medical cost). Furthermore, Vietnamese patients who are disabled by stroke may require rehabilitation and post-stroke care, which could cost another USD 213.0 (adjusted) and up to 990.7 per month (Nguyen, 2022), which is equivalent to USD 2,556–11,888 per year.

Our study has several limitations. In this study, we could only estimate the direct medical costs of IS treatment. The cost of illness includes direct non-medical and indirect costs, such as transportation to healthcare facilities, the cost of lodging and meals during hospitalization, loss of productivity from patients and caregivers, and costs incurred after stroke care and rehabilitation. A previous study found that 98.2% of stroke patients incurred direct non-medical costs, 73.1% incurred indirect costs, and 33.6% of the total stroke treatment costs (Pham, 2015). Without direct non-medical, indirect, and rehabilitation costs, our study findings could not estimate the total economic burden to AIS patients, even though the direct medical cost alone would already be catastrophic to those who did not have health insurance. Ischemic stroke not only poses an economic burden to the patients and their families but also to the healthcare system in Vietnam, as there are 200,000 new stroke incidents every year (Ministry of Health, 2022). Secondly, in this study, we could not collect any incurring costs the patient may have before being referred to our hospital, such as health care services performed at lower-class hospitals. This may underestimate the direct medical cost per AIS patient for each stroke occurrence. This issue can only be resolved if we use the social health insurance database; however, this database is not openly accessible at the moment. Lastly, in this study, we analyzed cost data from only one hospital; thus, the generalizability of the results may be restricted.

Conclusion

On average, the total direct medical cost per IS patient was USD 454.2 ± 313.8. The factors associated with higher direct medical costs were duration of stay, stroke severity, complications, comorbidities, and intravenous thrombolysis treatment. Stroke treatments are time-dependent, and reducing delayed hospital arrivals since stroke onsets is one of the key strategies to minimize stroke burden in Vietnam.

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