

Cost burden of neuroimaging during one-time admission for first-ever acute stroke in Nigeria

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ABSTRACT

الأهداف: لتحديد عبء تكلفة تصوير الأعصاب ودوره في التكاليف المباشرة للعلاج (HCs) لأول فترة للدخول لأول سكتة دماغية على الإطلاق.

الطريقة: قيمت كلا من الخصائص السريرية، والتكاليف المفصلة المباشرة ومجموع HCs لـ 170 مريض على التوالي مع أول السكتة الدماغية من أي وقت مضى، ادخل في مرفق الصحة العامة لدينا على مدى 15 شهراً.

النتائج: تم استعراض سجلات 170 مريض بالسكتة الدماغية. كان متوسط مجموع HCs للقبول مرة واحدة لكل مريض بالسكتة الدماغية \$183.30 دولاراً بتكلفة متوسطة يومية بلغت 15.86 دولاراً. كانت متوسط التكلفة للاختبارات الإشعاعية الأعلى من بين تكاليف المستشفى المصنفة. شكل تصوير الأعصاب على الأقل 99% من التكلفة على المرضى من بين الاختبارات الإشعاعية.

الخلاصة: أن العبء المالية للاختبار الإشعاعية، ولا سيما تصوير الأعصاب، مرتفع أثناء قبول المرضى للمرة الأولى لأول سكتة دماغية في بيئتنا.

Objectives: To determine the cost burden of Neuroimaging and its contribution to direct total hospitalization costs (HCs) during one-time admission for first-ever stroke.

Methods: The clinical characteristics, direct itemised costs and total HC's for 170 consecutive patients with first-ever stroke, admitted at our public tertiary health facility over a 15-month period were evaluated.

Results: The records of 170 stroke subjects were reviewed. The median total HC's for one-time admission per stroke patient was \$183.30 with a median daily cost of \$15.86. Median cost of radiological investigations was the highest among the categorized hospital costs. Among the radiological

investigations, neuroimaging accounted for at least 99% of cost to patients.

Conclusion: The financial burden of radiological investigations, particularly neuroimaging, is high during one-time admission of patients with first-ever stroke in our environment.

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The medical and economic burden of Stroke is immense.¹ It is the leading cause of long term disability and the second leading cause of death globally.² Economically, it imposes heavy financial burden on individuals and the society.^{2,3} In Nigeria, the prevalence of stroke is 14 per 1000 people and it has a case fatality rate of 40%. World Health Organization projects that approximately 80% of all stroke cases will occur in people living in low and middle income countries, including Nigeria.⁴ In the United States, there is increased interest in the economic aspects of stroke as a result of the prevailing emphasis on cost containment and managed healthcare/health insurance.⁵ In Nigeria, the National Health Insurance Scheme (NHIS) became fully operational in 2005.^{6,7} Out of a population of about 190 million, only 3% are registered in the NHIS.⁸ Therefore, over 90% of health financing is by private out-of-pocket expenditure.⁹ About 57% of the Nigerian

population falls below the poverty line which is defined as an average income of \$1 per day.¹⁰ The minimum monthly wage in Nigeria is 18,000 naira (57 US dollars).¹¹ With such indices, it is imperative to establish the cost burden of diseases, especially those with long term disabilities like stroke, for more effective healthcare planning, implementation and resources allocation for a healthier nation. Few studies have evaluated the cost of in-hospital stroke care in different populations with regional differences in total and itemized hospitalization costs.^{12,13-27} As there could be regional and institutional variations in the in-hospital algorithms for stroke care percentage contribution of itemized hospitalization costs to the total hospitalization cost have varied among these studies. Neuroimaging is required for all stroke patients presenting in our hospital. This is similar to what obtains elsewhere.¹³ Undergoing neuroimaging immediately after stroke has also been shown to be associated with better outcome and a higher number of quality adjusted life years.²⁸ There is no data on the cost burden of in-hospital care of managing stroke in Nigeria. Available data on cost burden of stroke is on the post-stroke period which showed that the minimum cost needed in a government hospital is ₦95,100 (\$600 as of 2012) and the minimum cost needed in a private hospital is ₦767,900 (\$4860 as of 2012), within the first 36 months of post stroke affectation.² A local study to determine the direct cost of in-hospital stroke care and how different hospital services contribute to the total direct cost in our environment where health insurance coverage is limited is needed. This will provide data for government policy makers to develop a health system that will minimize the financial burden of in-hospital care of stroke on individuals and the society. This study was done to evaluate the contributions of itemized hospitalization costs, particularly neuroimaging expenses, to total hospitalization cost during one-time admission for first-ever stroke in a tertiary hospital in order to guide policy decisions.²⁹

Methods. Study design. This was a retrospective cross sectional observational study conducted on 170 consecutive patients admitted and managed for first-ever stroke in a tertiary hospital (Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Osun

State, Southwest, Nigeria) over a 15-month period (January 2016 - March 2017). The study protocol was approved by the institution's Ethics and Research Committee and informed consent was obtained from the participants. Literature search for review was conducted by interrogating the Pubmed and Google Scholar databases as well as identifying relevant studies from the reference lists of the articles obtained.

Hospital characteristics. Our hospital is located in the South-Western zone of Nigeria with a land mass of 1902km² and population of approximately 644,373 people. It is a major tertiary referral centre serving about 7.7 million people in the Southwestern region of Nigeria. The hospital has a 24-hour emergency service for stroke with a stroke team consisting of 3 Neurologists, 2 Neurosurgeons, 3 Neuro-radiologists, one Anaesthesiologist, 2 Neuro-physiotherapists, and 5 stroke Nurses. There are 10 neurology ward beds, 2 intensive care beds and 10 neurosurgery ward beds. Neuroimaging facilities available include computerized tomography (CT) and Magnetic Resonance Imaging (MRI).

Inclusion criteria. We limited the study to all stroke cases who had neuroimaging and received in-hospital care for stroke until formally discharged within the study period.

Exclusion criteria. Records of patients who had delayed medical attention/care due to financial difficulties, discharged against medical advice and those with paucity of details of management were excluded from the study. All non-hospital services and indirect costs were not included in the study.

Data collection. A bottom-top direct microcosting methodology was used to estimate cost. A documentation review of the stroke database and patients' records in our hospital was done. Data were obtained on socio-demographic variables such as age, gender, occupation and monthly income; and clinical data such as the type of stroke, length of hospital stay and individual risk factors such as hypertension, diabetes, obesity, atrial fibrillation, chronic kidney disease, alcohol use and smoking. Data on direct costs was defined as the actual currency expenditures on services described under the following costs categories: inpatient care cost- which includes total operational charges, facility charges, bed and ward charges; diet cost- which includes cost of meals provided to patients by the hospital; radiological investigations cost- which include cost of neuroimaging (Computerized Tomography (CT) scan or Magnetic Resonance Imaging (MRI)), Chest X-Ray (CXR), Carotid Doppler, Abdominal Ultrasound (USS), Renal Doppler; laboratory investigations- which

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include full blood count, serum lipids, coagulation profile (PT, PTTK), Erythrocyte Sedimentation Rate (ESR), Serum Electrolyte/Urea/Creatinine; cardiac study- which include echocardiography (ECHO) and electrocardiography (ECG); medication/drug cost-drug charges; and physiotherapy cost.

Calculation of length of stay in the hospital for stroke subjects managed in the ICU included stay in the ICU and neurology ward (after they were subsequently discharged into the neurology ward). Estimated monthly income of the subjects was obtained by interview. Cost is presented in Naira and United States Dollars equivalent (1 US dollars = 457 Naira as of March 15, 2017).

In-hospital care for stroke subjects. Neuroimaging is mandatory for all patients with stroke in our hospital. Medications used included anti-hypertensives, anti-diabetics, anti-platelets, anticoagulants, and anti-lipids/ statins. The anticoagulant medications included intravenous unfractionated Heparin, Dabigatran, and Warfarin. The antiplatelet medications are Aspirin and Clopidogrel.

Antidiabetic drugs included insulin and oral antidiabetic agents (Glibenclamide, Metformin).

Anti-hypertensives included calcium channel blockers, angiotensin converting enzymes (ACE) inhibitors, angiotensin receptor blockers (ARB), beta-blockers (Atenolol, Labetalol), alpha-methyl dopa, diuretics (Thiazides, Frusemide, Spironolactone), and alpha-adrenergic blockers. Statins/antilipids included (Atorvastatin, Fluvastatin).

In addition, the subjects also underwent ancillary investigations including laboratory investigations (Serum Electrolyte/Urea/Creatinine assay, fasting blood glucose, complete blood count, fasting serum lipid profile, erythrocyte sedimentation rate, coagulation profile, abdominopelvic ultrasound, chest x-ray, lower limb Doppler, carotid Doppler, and cardiac studies (echocardiography, electrocardiography). In-hospital physical rehabilitation was individualized and provided by the Neuro-physiotherapists following a consult to them by the Neurologists. The stroke team had 2-weekly review meetings to minimize variations in patients' care and discharge plans.

Hospital costs. Costs for intensive care unit (ICU), neurology ward, neuroimaging, abdominopelvic ultrasound, chest radiography, lower limb Doppler, physiotherapy, meals, echocardiography, electrocardiography, laboratory investigations (Serum Electrolyte/Urea/Creatinine, Fasting blood sugar, Complete blood count, Fasting serum lipid profile, ESR, and coagulation profile) are officially fixed by the hospital management.

Cost of ICU admission, neuroimaging, physiotherapy, meals and echocardiography were not covered by the NHIS package while all other itemized categorized costs in this study were covered. For the costs covered by NHIS, the patients pay a tenth of the cost for drugs while ward charges, abdominopelvic ultrasound, CXR, lower limb Doppler, and laboratory investigations were totally covered by the NHIS package.

Data analysis. Statistical analysis was done using the Statistical Package for Social Sciences (IBM Corp., Armonk, NY, USA) software version 20.0 for windows. Categorical data were presented as frequencies and percentages while continuous data were presented as median, minimum, and maximum values. Kolmogorov-Smirnov's test of normality was conducted on the cost variables and found to be skewed positively. Chi square test was used to compare the proportions of subjects with different characteristics who paid out of pocket and those on NHIS. As the cost data were highly skewed positively, Mann Whitney U test was used for bivariate analysis to explore the presence of any significant differences in cost categories among different variable groups. Spearman correlation was used to evaluate the relationship between categorized hospitalization cost and number of risk factors. The level of statistical significance was set at $p \leq 0.05$.

Results. The records of 170 stroke subjects with mean age 61.41 ± 13.92 years were reviewed. There were almost as many females (48.2%) as there were males (51.8%). The ratio of subjects with ischemic stroke to those with haemorrhagic stroke was 1.5:1 with about 85.9% of all subjects being discharged home after their first admission for stroke. The modal number of risk factors in our subjects was one (for example, systemic hypertension). Estimated monthly income was less than \$100 in 117 (68.8%) subjects.

Out of the 170 subjects, 122 (71.8%) paid out of pocket (OOP) compared to the 48 (28.2%) on National Health Insurance Scheme (NHIS). Eighty-seven (71.3%) of these OOP subjects earn less than a 100 dollars per month as compared to 30 (62.5%) of 48 subjects on NHIS who earn the same (Table 1).

The median total hospitalization cost (HC) per patient was \$183.30 (₦83,770) with a median daily cost of \$15.86 (₦7,248) (Table 2).

Median cost of Radiological investigations (\$85.45/ ₦39,050) was highest among the categorized itemized costs followed by laboratory investigations (\$25.82/ ₦11,800) and feeding (\$24.07/ ₦11,000), (Table 2).

The median costs of the total HC and all categorised

itemised costs were significantly higher ($p < 0.001$) in the OOP group than the NHIS group except for feeding ($p = 0.983$) and physiotherapy ($p = 0.795$), (Table 3). Neuroimaging accounted for nearly all the cost of radiological investigations (100% of the cost of radiological investigations for NHIS and 99.8% for OOP subjects), (Table 4). Ischemic stroke subjects significantly paid less for radiological investigations

than their haemorrhagic counterparts ($p < 0.001$) for OOP subjects while the cost burden of radiological investigations was comparable ($p = 0.319$) between the ischemic and haemorrhagic subjects for those on NHIS (Table 5).

The number of risk factors had very weakly positive but significant correlation with cost of drugs when both groups are combined ($r = 0.166$, $p = 0.030$) and in the OOP group ($r = 0.270$, $p = 0.003$). Similar result was obtained when number of risk factors were compared with cardiac studies in the combined group ($r = 0.218$, $p = 0.04$) and the OOP group ($r = 0.219$, $p = 0.015$). Other itemized categorized costs showed no significant association with number of risk factors in the combined group and among those paying out of pocket. A comparison of our findings to previous cost reports is shown in Table 6.

Table 1 - Subject characteristics among patients on National Health Insurance Scheme (NHIS) and those paying out of pocket (OOP). N=170

Variables	OOP n=122		NHIS n=48		Total	χ^2	df	P-value
	n	(%)	n	(%)				
<i>Age in years</i>								
<40	9	81.8	2	18.2	11			
40 – 49	14	73.7	5	26.3	19	1.007	4	0.909
50 – 59	29	69.0	13	31.0	42			
60 – 69	31	68.9	14	31.1	45			
≥70	39	73.6	14	26.4	53			
<i>Gender</i>								
Male	62	70.5	26	29.5	88	0.155	1	0.694
Female	60	73.2	22	26.8	82			
<i>Estimated monthly income in US dollars</i>								
<100.00	87	74.4	30	25.6	117	1.889	2	0.389
100.00 - 200.00	25	69.4	11	30.6	36			
>200.00	10	58.8	7	41.2	17			
<i>Time to presentation in hours</i>								
<6	21	75.0	7	25.0	28	1.778	3	0.620
6 - 24	38	69.1	17	30.9	55			
25 - 72	30	78.9	8	21.1	38			
>72	33	67.3	16	32.7	49			
<i>Type of stroke</i>								
Ischemic	71	69.6	31	30.4	102	0.585	1	0.278
Hemorrhagic	51	75.0	17	25.0	68			
<i>Number of risk factors*</i>								
1	39	70.9	16	29.1	55	0.041	3	0.998
2	36	72.0	14	28.0	50			
3	36	72.0	14	28.0	50			
≥4	11	73.3	4	26.7	15			
<i>Duration of hospital stay in days</i>								
≤7	39	78.0	11	22.0	50	6.296	3	0.098
8-14	44	69.8	19	30.2	63			
15-21	21	58.3	15	41.7	36			
>21	18	85.7	3	14.3	21			
<i>Outcome</i>								
Dead	18	75.0	6	25.0	24	2.272	2	0.321
Discharged	103	70.5	43	29.5	146			

χ^2 - chi square test statistic, OOP - out of pocket, NHIS - national health insurance scheme, *Risk factors evaluated include hypertension, diabetes mellitus, dyslipidemia, coronary artery disease, obesity, alcohol consumption, and smoking.

Discussion. This study analysed the percentage contributions of categorized care costs, particularly neuroimaging, to the total hospitalization cost and evaluated differences in hospitalization costs between patients paying out of pocket and on NHIS during a single admission for first-ever stroke.

Although a direct comparison is not possible due to varying degrees of heterogeneity of the studies, total and daily hospitalization costs of stroke in our study are lower than those reported in previous studies.¹¹⁻²⁶ This may be attributable to differences in available medicare resources, unit cost of hospital charges, reimbursement systems and healthcare delivery utilization pattern in the different countries. The total and daily costs in

Table 2 - Direct medical cost for 170 patients (including insurance company inputs).

Variables	Cost in \$ Median (Q ₁ -Q ₃)	Cost in ₦ Median (Q ₁ -Q ₃)
Total*	183.30 (151.67-207.58)	83770 (69313-94863)
Radiological investigations	85.45 (83.15-88.84)	39050 (38000-40600)
Diets	24.07 (15.32-37.20)	11000 (7000-17000)
In-patient care	18.05 (11.49-27.90)	8250 (5250-12750)
Laboratory	25.82 (15.97-25.82)	11800 (7300-11800)
Physiotherapy	25.32 (12.69-25.38)	11600 (5800-11600)
Drugs	2.94 (1.75-6.12)	1345 (800-2798)
Cardiac studies	4.49 (0.00-4.49)	2050 (0-2050)

*Skewness of this distribution is 1.888 and kurtosis is 6.765

Table 3 - Comparing categorized hospital costs among patients on National Health Insurance Scheme (NHIS) and those paying out of pocket (OOP). N=170

Categorized hospitalization costs in UD dollars (\$)	OOP n=122	NHIS n=48	P-value*
	Median (Q ₁ -Q ₃)	Median (Q ₁ -Q ₃)	
Total	182.98 (157.00-213.22)	144.67 (119.55-162.77)	<0.001
Radiological investigations	85.45 (83.15-88.84)	83.15 (83.15-83.15)	<0.001
Diets	25.16 (15.32-37.20)	24.07 (17.51-35.01)	0.983
In-patient care	18.87 (11.49-27.90)	0.00 (0.00-0.00)	<0.001
Laboratory	25.82 (25.82-25.82)	6.56 (6.56-6.56)	<0.001
Physiotherapy	25.38 (12.69-25.38)	25.38 (12.69-25.38)	0.795
Drugs	3.23 (1.75-6.08)	0.27 (0.14-0.62)	<0.001
Cardiac studies	4.49 (0.00-4.49)	0.00 (0.00-0.00)	<0.001

*Independent samples Mann-Whitney U test was used to compare the distributions; OOP - Out of pocket; NHIS - National Health Insurance Scheme

Table 4 - Comparing costs of neuroimaging with other radiological investigations in US \$. N=170

Variables	Neuroimaging	Others	P-value*
	Median (range)	Median (range)	
OOP n=48	83.15 (83.15-83.15)	3.39 (0.00-5.69)	<0.001
NHIS n=122	83.15 (83.15-83.15)	0.00 (0.00-0.00)	<0.001

*Independent samples Mann-Whitney U test was used to compare the distributions; OOP - out of pocket, NHIS - national health insurance scheme

Table 5 - Comparison of cost of radiologic investigations in US\$ across stroke subtypes. N=170

Stroke types	N		Median (Q ₁ -Q ₃)	P-value*
	n	(%)		
OOP				
Ischemic	71	58.2	85.45 (83.15-85.45)	<0.001
Hemorrhagic	51	41.8	88.84 (86.54-88.84)	
NHIS				
Ischemic	31	64.6	83.15 (83.15-83.15)	0.319
Hemorrhagic	17	35.4	83.15 (83.15-83.15)	

*Independent samples Mann-Whitney U test was used to compare the distributions; OOP - out of pocket, NHIS - national health insurance scheme

Nigeria appear far less than those in these other places. The relatively less sophisticated health care facilities available for stroke management in Nigeria may be

partly responsible for the lower cost figures obtained in our study. Furthermore, another contributory factor may be the weakness of our local currency (Naira) relative to the US dollar (having lost more than 100% of its value over the last 2 years) and thus lower US dollar values are obtained on conversion.

Chang et al²⁶ studied the cost to provide acute care to 360 first-ever ischemic stroke patients in Taiwan, a more developed country than Nigeria. Hospital charges were used for cost analysis. In their study, the median cost per patient was \$841 and the median cost per day was \$121. In the study by Gnonlonfoun et al²³ in Benin, a developing country, the average expenses were \$1030.1±\$101.7.

A direct comparison of our study with previous studies on the economic costs of stroke is difficult because the studies differ in cost categories evaluated, number of patients assessed, study setting, and unit costs of treatment procedures.

Decades ago, the diagnosis of stroke was largely dependent on bedside clinical methods. The knowledge of the location and nature of the underlying pathologic process could only be verified independently post-mortem which seriously hampered initial attempts at developing and implementing appropriate therapeutic interventions.²⁷ There has been better understanding of the cerebrovascular and tissue pathology with neuroimaging techniques like Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound (USS) and Catheter angiography in the past 30 years which has created a wide array of opportunities for acute treatment and secondary prevention of stroke.²⁷ Neuroimaging (47%) had the highest contribution to total hospitalization cost in our study followed by laboratory investigations and physiotherapy (14% each). This is in contrast to Japanese (69%), Greek (60%) and American (50%) studies where beds and staffs had the highest contributions to total hospitalization cost.^{13,14,30} In China, drugs (49%) had the highest contribution to total HC while it was room and board in Korea (31%).^{15,17} This variation in the highest contributing categorized cost to total HC may be due to regional differences in the unit cost of hospital charges among the studies. Cost of imaging (which ranked highest in this study) accounted for 6% of the total HC in Japan, 10% in Greece, 19% the United States of America, 9% in China and 30% in South Korea.^{13-15,17,30} These percentage contributions of imaging costs are lower than that in our study.

Although total hospitalization costs (HCs) per stroke subject in our study is lower than those of most previous studies, imaging accounted for a much

Table 6 - International comparison of first-time stroke costs.

Country	Setting	Sample size	Duration	Total cost	ImC	HCC
Nigeria	HB	170	15 mths	\$183 \$16/day	\$85	Imaging
Japan ¹³	HB	179	12 mths	\$6,887	\$426	Bed & Staff
Congo ¹⁶	HB	90	6 mths	€158	NS	NS
S/Africa ¹⁸	CB	103	1 yr	\$283,465/yr	\$2,160	Inpatient Care
Tanzania ¹⁹	CB	16	6 mths	\$149,286	NS	NS
Togo ²⁰	NS	412	12 mths	I: €430 H: €940	NS	NS
S/Korea ¹⁷	HB	1,600	6 yrs	\$2,787	\$1,075	Inpatient Care
S/Korea ²¹	HB	749	2 yrs	\$401/day	\$1,387	Laboratory
Greece ³⁰	HB	429	18 mths	€3,625	I: €3,215 H: €5,306	NS
USA ¹⁴	HB	191	6 mths	\$4,408	19%	Inpatient Care
Senegal ²²	HB	71	12 mths	\$157/patient	NS	NS
Benin ²³	HB	122	7 mths	\$144.8-\$9393.8	NS	NS
Italy ²⁴	HB	245	1 yr	\$3,289 \$251/day	NS	NS
Singapore ¹²	HB	426	NS	\$5,031	14.5%	Ward Costs
Japan ²⁵	HB	316	4 yrs	\$7,874	13%	Fundamentals
Taiwan ²⁶	HB	360	1 yr	\$841/patient \$121/day	NS	Ward/Physician

Mths - months, Yr - year, ImC - imaging cost, NS - not stated, HCC - highest cost category, HB - hospital based, CB - community based, I - ischemic stroke, H - hemorrhagic stroke, S/Africa - South Africa, S/Korea - South Korea, B/Faso - Burkina Faso, \$ - US Dollars, € - Euros

higher percentage of the total HCs. This may be due to differences in the unit hospital care charges and reimbursement systems as neuroimaging cost is being borne solely by the stroke subjects in our country unlike what may obtain in other countries. In this study, neuroimaging costs (CT or MRI) accounted for 100% of the cost burden of radiological investigations in stroke subjects on NHIS and accounted for about 99.8% of the cost of radiological investigations in those that paid out of pocket. The NHIS and OOP groups bore similar cost on neuro-imaging, but the NHIS group bore no cost on other radiological non-neuro-imaging studies, resulting in a significant difference in cost of radiological investigations between the 2 groups.

Our findings showed that the OOP subjects had higher total and categorized costs, than the NHIS group; except for physiotherapy and diet, which are excluded from the NHIS package. The 28% of our stroke subjects who were on NHIS were therefore equally burdened with the cost of neuroimaging, physiotherapy and diet as the OOP subjects.

The cost of radiological investigations was higher in haemorrhagic stroke patients (especially for those on NHIS) compared to their ischemic counterparts. This is similar to the findings of Gioldasis et al³⁰ in Greece.

In this study, cost of cardiac studies and drugs correlated weakly with number of risk factors. Therefore, effort to decrease the development of these risk factors in our environment may contribute to a reduction in these 2 categorized hospitalization costs.

Despite being a single hospital-based analysis, this study provides data on the short-term inpatient care and costs for first-ever stroke managed in a public tertiary hospital in Nigeria which could help guide policy making on stroke financing. A future multicentre study will attempt to evaluate the general cost of acute stroke nationwide. In addition, because stroke patients are sometimes permanently dependent after the acute phase, a cost analysis of long-term care in our environment would be necessary.

The main limitation of our study is that it evaluated only direct costs. Though direct costs are useful for planning healthcare funding, indirect cost estimation would further strengthen the justification for public spending on stroke care.

In conclusion, the financial burden of neuroimaging is high during one-time admission of patients with first-ever stroke in our environment. Due to the high contribution of neuroimaging to the cost of radiological investigations and subsequently total HC, expansion

of NHIS coverage to more people and also to include defraying neuroimaging costs will help to reduce the financial burden of stroke on patients.

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