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Original Paper

Stroke Mortality in Kenya's Public Tertiary Hospitals: A Prospective Facility-Based Study

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Keywords
Stroke · Mortality · Survival · Kenya · Sub-Saharan Africa

Abstract
Background: Despite the increasing global burden of stroke, there are limited data on stroke from Kenya to guide in decision-making. Stroke occurrence in sub-Saharan Africa has been associated with poor health outcomes. This study sought to establish the stroke incidence density and mortality in Kenya's leading public tertiary hospitals for purposes of informing clinical practice and policy. ***Methods:*** This is a prospective study conducted at Kenya's leading referral hospitals, namely, Kenyatta National Hospital (KNH) and Moi Teaching and Referral Hospital (MTRH). Adult patients with confirmed cases of stroke were recruited from February 2015 to January 2016 and followed up for a minimum period of 1 year. The WHO 2006 Stroke STEPS instrument was used to collect data on incidence and mortality at days 10 and 28 and every 3 months for 24 months. The person-time of follow-up was computed from admission to death, loss to follow-up, or the end of the study. A survival regression analysis was done using the Cox proportional hazards model. ***Results:*** A total of 719 patients were recruited (KNH: n = 406 [56.5%]; MTRH: n = 313 [43.5%]). The mean age was 58.6 ± 18.7 years, and the male-to-female ratio was 1:1.4. Ischemic stroke accounted for 56.1% of the stroke cases. The

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peak age for stroke was between 50 and 69 years, when 36.3% of the cases occurred. Mortality at day 10 and day 28 was 18.4 and 26.7%, respectively. The inpatient mortality rate was 21.6%. The stroke incidence density was 507 deaths per 1,000 person-years of follow-up. The mean survival time was significantly different between inpatients (13.9 months; 95% CI: 13.0–14.7) and outpatients (18.6 months; 95% CI: 17.2–19.9) ($p < 0.001$). A 1-year increase in age increased the hazard by 1.8%. Inpatients had a 3.9-fold increase in hazard compared to outpatients. ***Conclusions:*** Mortality due to stroke is high, with poor survival observed in the first year after stroke. The risk of death increases with increasing age and duration of hospital stay. There is need for attention to quality of care and long-term needs of stroke patients to mitigate the high mortality rates observed. Public health initiatives aimed at early screening and diagnosis should be enhanced. Further research is recommended to establish the true burden of stroke at the community level to inform appropriate mitigation measures.

Introduction

The global burden of stroke is increasing, with 8% of all first-ever strokes occurring in Africa. There are limited data on stroke from sub-Saharan Africa, with the resultant information deficit hampering evidence-based decision-making. The few studies on stroke in Africa provide a glimpse of poor health outcomes associated with the disease. For instance, inpatient stroke mortality by day 30 has been reported at 19.3% in the Democratic Republic of Congo [1], 33.3% in Tanzania, 43.2% in Ghana, and 23.2% in Cameroon [2–4]. The 6-month stroke mortality rate in South Africa is 23% [5, 6].

Some of the factors cited as contributing to the increased risk of death include stroke severity, functional disability, high blood pressure, increasing age, dysphagia, and infections such as pneumonia [7–9]. Low survival rates after ischemic stroke have been attributed to lack of access to acute management of strokes, socioeconomic factors, and variations in geographic locations [10]. Female stroke survivors have been found to have a higher probability of survival 1 year after stroke [11].

There is little information on the actual stroke burden in Kenya. Hardly any prospective studies have been done to assess stroke outcomes and survival among patients attended to in Kenyan public hospitals. This study sought to establish the stroke incidence density and mortality in Kenya's leading public tertiary hospitals for purposes of informing policy and practice.

Subjects and Methods

Study Sites

The study was conducted at Kenyatta National Hospital (KNH) located in Nairobi, the capital city of Kenya, and Moi Teaching and Referral Hospital (MTRH) in Eldoret, Western Kenya. KNH and MTRH are the largest public tertiary hospitals in Kenya with a bed capacity of 1,800 and 850, respectively, and they predominantly serve urban and rural populations, respectively.

Study Design and Population

This is a prospective study among stroke inpatients and outpatients diagnosed and/or attended to at KNH and MTRH. Patients were recruited from February 2015 to January 2016 and followed up for a minimum period of 1 year.

Criteria for Patient Selection

The study included adult patients with confirmed cases of stroke based on imaging results. All stroke patients were targeted to minimize the likelihood of selection bias. The combination approach (hot and cold) case finding method was used to identify stroke cases.

Sample Size Estimation

The sample size was based on the unknown proportion of the most prevalent stroke type (thus, 50% assumed), a desired precision for the indicator of 5% and 95% confidence level. Fisher's formula [12] for estimating the minimum sample size was used, giving a minimum sample of 385. This number was achieved by recruiting stroke patients over a 1-year period, with each hospital contributing a minimum of 200 patients.

Recruitment and Training of Field Staff

Research assistants with a medical background were recruited and trained on the protocol and study procedures using predesigned data collection tools. The WHO STEPwise Approach to Stroke Surveillance Manual was used for training [13]. Training and certification were done to harmonize data collection methods between researchers. Piloting of the study tools was done, followed by definitive data collection.

Data Collection

Stroke inpatients were recruited upon admission, while outpatients were recruited from the neurology clinic and at casualty (emergency room department) at both hospitals. Data collected included details on sociodemographics, stroke events, case management, and discharge status using the WHO 2006 Stroke STEPS instrument. The instrument collects in a standardized manner basic epidemiological data on incidence, major risk factors, morbidity and mortality trends, and intervention strategies in recent (acute) stroke. Follow-up entailed assessing clinical outcomes using the modified Rankin Scale, and gathering information on patients' vital status after discharge. The participants recruited during the 1-year period were followed up at intervals of 10 days, 28 days, and every 3 months for 24 months. A complete follow-up was carried out for all the participants for day 10, day 28, 3 months, 6 months, 9 months, and 12 months. For those discharged, follow-up was done through telephone interviews.

Data Management and Analysis

To ensure the collection of accurate data, a two-level interview form review process was put in place. The data were doubly entered using the Microsoft Access application. Cleaned and validated data were then exported into the IBM Statistical Package for Social Sciences version 21.0 (IBM SPSS) for analysis. The databases (Microsoft Access and IBM SPSS formats) were copied onto external hard disks for backup and storage.

The distribution characteristics for continuous data were confirmed using the Kolmogorov-Smirnov test and exploratory data analysis. The analysis involved descriptive statistics. To test for associations between independent variables and stroke type, for example, the Student *t* test (normally distributed data) or the Mann-Whitney U test (skewed data) was carried out for continuous variables, and the χ^2 test or Fisher's exact probability test, where applicable, to categorical data. The person-time of follow-up of each participant was computed from admission to death, loss to follow-up, or the end of the study, whichever came first. Survival regression analysis was done using the Cox proportional hazards model.

Table 1. Characteristics of the stroke patients in KNH and MTRH

Characteristics	KNH (*n* = 406)	MTRH (*n* = 313)	Overall	*p* value
Sex				0.144
Male	166 (40.9)	145 (46.3)	311 (43.3)	
Female	240 (59.1)	168 (53.7)	408 (56.7)	
Mean age ± SD (95% CI), years			58.6±18.7 (57.3–60.0)	
Age group				<0.001
<30 years	34 (8.4)	11 (3.5)	45 (6.3)	
30–39 years	49 (12.1)	26 (8.3)	75 (10.4)	
40–49 years	63 (15.5)	54 (17.3)	117 (16.3)	
50–59 years	70 (17.2)	50 (16)	120 (16.7)	
60–69 years	98 (24.1)	43 (13.7)	141 (19.6)	
70–79 years	48 (11.8)	67 (21.4)	115 (16.0)	
≥80 years	44 (10.8)	62 (19.8)	106 (14.7)	
Education				<0.001
No formal schooling	62 (15.3)	135 (43.1)	197 (27.4)	
Primary school	211 (52.0)	111 (35.4)	322 (44.8)	
Secondary school completed	89 (21.9)	42 (13.4)	131 (18.2)	
College/university completed	36 (8.9)	25 (8)	61 (8.5)	
Unknown	8 (2.0)	0 (0)	8 (1.0)	
Occupation				<0.001
Formal employment	99 (24.4)	36 (11.6)	135 (18.8)	
Self-employed	177 (43.5)	183 (58.5)	360 (50.0)	
Student	8 (2.0)	2 (0.6)	10 (1.4)	
Homemaker/housewife	18 (4.4)	36 (11.5)	54 (7.5)	
Retired	35 (8.6)	11 (3.5)	46 (6.4)	
Unemployed	69 (17.0)	45 (14.4)	114 (15.9)	
Stroke subtype				0.002
Hemorrhagic	199 (63.0)	117 (37.4)	316 (43.9)	
Ischemic	207 (51.4)	196 (48.6)	400 (56.1)	
Median blood pressure (IQR), mm Hg				
Systolic			155 (40)	
Diastolic			90 (26)	

Values are presented as *n* (%) unless specified otherwise. KNH, Kenyatta National Hospital; MTRH, Moi Teaching and Referral Hospital.

Results

A total of 719 patients (KNH: *n* = 406 [56.5%]; MTRH: *n* = 313 [43.5%]) with a mean age of 58.6 ± 18.7 years participated in the study. Overall, 311 (43.3%) were male and 408 (56.7%) female, giving a male-to-female ratio of 1:1.4. The majority (482 [67%]) were above 50 years of age, with 514 (71.5%) having received formal education and 135 (18.8%) being in formal employment. Ischemic stroke accounted for 56.1% of the stroke cases. Table 1 shows the sociodemographic and clinical characteristics of the participants by health facility.

The proportion of females with ischemic and with hemorrhagic stroke was 57.6 and 54%, respectively, whereas the respective proportion among men was 42.4 and 46%. The peak age for stroke was between 50 and 69 years, when 261 (36.3%) of the cases occurred.

Stroke Incidence Density and Mortality

All participants were followed up for a minimum period of 1 year. Mortality was 18.4% (ischemic: 15.4%; hemorrhagic: 22.2%; $p = 0.02$) by day 10 and 26.7% (ischemic: 23.8%;

Table 2. Distribution of 1-year cumulative mortality by stroke type among patients in KNH and MTRH

Follow-up time	One-year cumulative mortality by stroke type, %			*p* value
	ischemic (*n* = 403)	hemorrhagic (*n* = 316)	total (*n* = 719)	
10 days	15.4	22.2	18.4	0.02
28 days	23.8	30.4	26.7	0.047
3 months	33.7	34.5	34.1	0.82
6 months	39.5	35.8	37.8	0.31
9 months	43.4	36.4	40.3	0.058
12 months	44.9	37.7	41.7	0.052

KNH, Kenyatta National Hospital; MTRH, Moi Teaching and Referral Hospital.

Table 3. Distribution of deaths and loss to follow-up by follow-up time among patients at KNH and MTRH

Follow-up time	Subjects followed up, *n*	Status after follow-up time					
		alive		lost to follow-up		dead	
		n	%	*n*	%	*n*	%
10 days	719	578	80.4	9	1.3	132	18.4
28 days	578	515	88.6	3	1.0	60	10.4
3 months	515	447	86.6	15	3.1	53	10.3
6 months	447	414	92.6	6	1.3	27	6.0
9 months	417	394	93.8	5	1.9	18	4.3
12 months	394	363	92.1	21	5.3	10	2.5
15 months	300	295	98.3	1	0.3	4	1.3
18 months	220	211	95.9	4	1.8	5	2.3
21 months	104	98	94.2	6	5.8	0	–
24 months	3	3	100	0	–	0	–
Total (out of 719)				67	9.3	309	42.97

KNH, Kenyatta National Hospital; MTRH, Moi Teaching and Referral Hospital.

hemorrhagic: 30.4%; $p = 0.05$) by day 28, as shown in Table 2. The cumulative mortality rate by month 3 was 245 (34.1%), by month 6 it was 272 (37.8%), by month 9 it was 290 (40.3%), and by month 12 it was 300 (41.7%). High mortality was recorded in the first 3 months of follow-up (18.4% by day 10, 10.4% by day 28, and 10.3% by month 3, respectively); mortality then decreased with the increase in follow-up time, as shown in Table 3. The stroke incidence density was 507 deaths per 1,000 person-years of follow-up.

Stroke Survival by Sex, Stroke Type, Facility, and Inpatient/Outpatient Status

The mean survival time was 15.3 months (95% CI: 14.1–16.5) among males and 14.2 months (95% CI: 13.2–15.3) among females, which was not statistically significantly different ($p = 0.16$). The mean survival time was 14.2 months (95% CI: 13.1–15.2) among patients with ischemic stroke and 15.4 months (95% CI: 14.1–16.6) among patients with hemorrhagic stroke ($p = 0.12$). By site, the mean survival time was 15.2 months (95% CI: 14.1–16.3) among stroke patients at KNH and 12.5 months (95% CI: 11.4–13.5) among stroke patients at MTRH ($p = 0.14$). During the 24-month study period, 639 patients (88.9%) were admitted, of whom

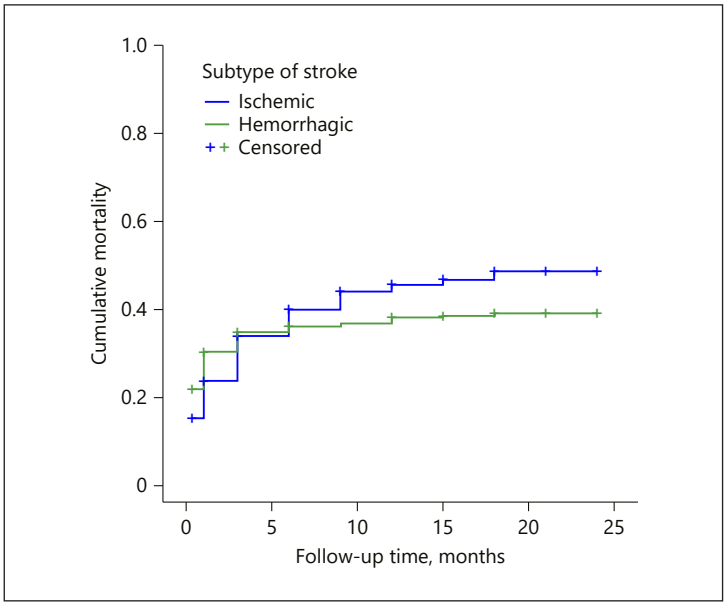

Fig. 1. Mortality rate by stroke type among patients at Kenyatta National Hospital and Moi Teaching and Referral Hospital (p = 0.12).

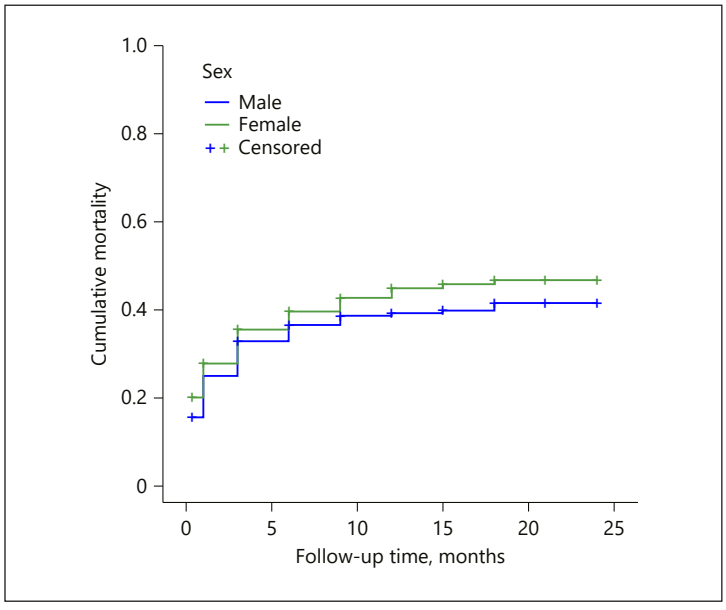

Fig. 2. Mortality rate by sex among patients at Kenyatta National Hospital and Moi Teaching and Referral Hospital (p = 0.16).

387 (60.6%) spent less than 10 days in hospital. The inpatient mortality rate was 21.6%. Figures 1–4 show the mortality rates by stroke type, sex, health facility, and inpatient/outpatient status, respectively. A significant difference ($p < 0.001$) in survival time was observed between inpatients (13.9 months; 95% CI: 13.0–14.7) and outpatients (18.6 months; 95% CI: 17.2–19.9).

The survival regression analysis showed that a 1-year increase in age increased the hazard by 1.8%, and that inpatients had a 3.9-fold increase in hazard compared to outpatients. Figure 5 shows the stroke mortality function after adjustment for sex, age, stroke type, inpatient/outpatient status, and health facility.

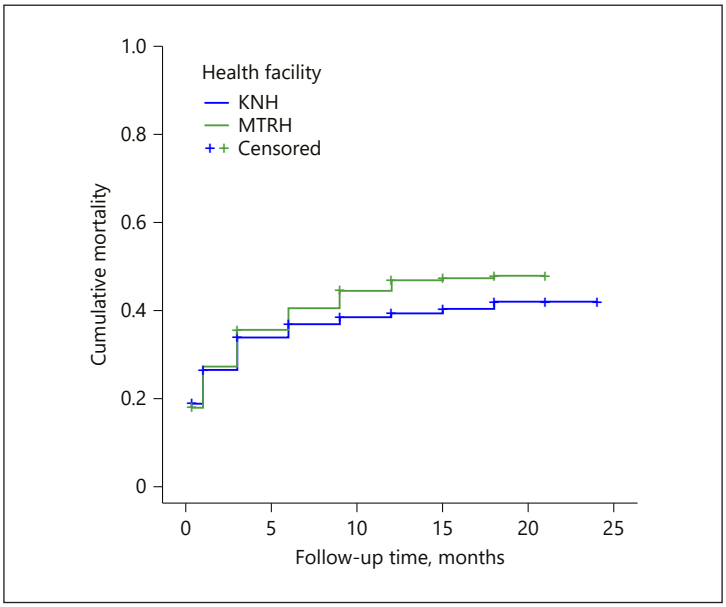

Fig. 3. Mortality by health facility among patients at Kenyatta National Hospital (KNH) and Moi Teaching and Referral Hospital (MTRH) ($p = 0.14$).

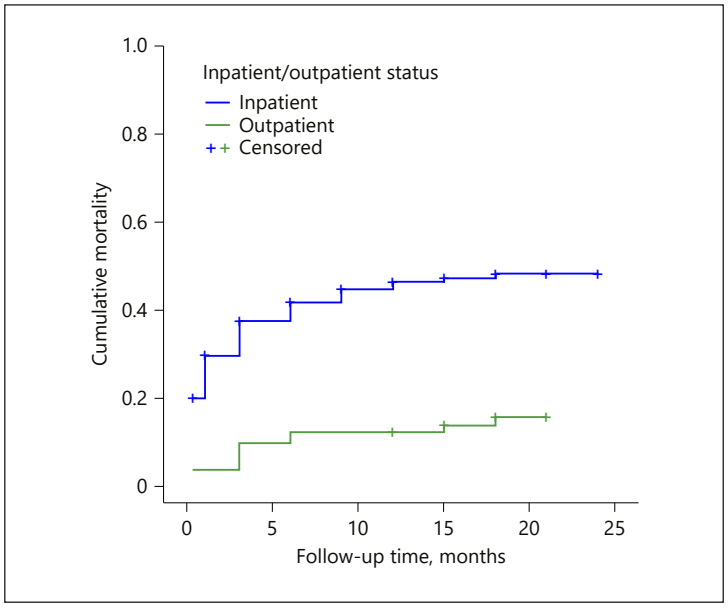

Fig. 4. Mortality rate by inpatient/outpatient status among patients at Kenyatta National Hospital and Moi Teaching and Referral Hospital ($p < 0.001$).

Discussion

Our study shows a high proportion of ischemic strokes overall, with women being affected more strongly and men surviving longer. The stroke incidence density and mortality remain high in the current setup. Hemorrhagic stroke contributed the most to mortality by day 10 and day 28. There were significant differences in patient survival, with outpatients surviving longer than inpatients. The risk of death increased with increasing age and inpatient status.

This is the first prospective study that provides estimates of stroke incidence density and survival in Kenya's largest public tertiary hospitals. The high inpatient mortality found has previously been observed in Kenya, Uganda, Ghana, and Nigeria [14–17]. The quality of care and performance of public health facilities in the management of stroke are factors that

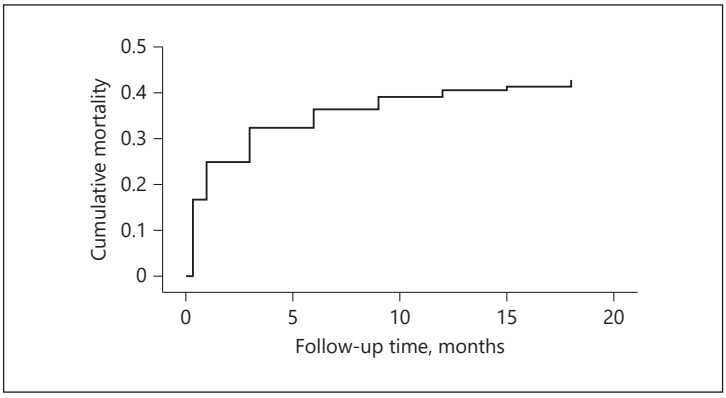

Fig. 5. Stroke mortality function at the mean of the covariates (after adjustment for sex, age, stroke type, inpatient/outpatient status, and health facility).

require further examination. There is also a need to assess the geographical distribution of and access to acute stroke care services in Kenya to guarantee a reliable and efficient system of stroke care [10, 18]. Time to treatment is an important prognostic factor for outcome, and investment in specialized stroke treatment centers is key [19]. Our findings also support the reported impact of stroke severity on short-term but not so much on long-term survival [20], with differences in survival observed between the stroke types. Close to two-thirds of the patients spent less than 10 days in hospital. The role of the community in providing long-term care should therefore be explored and appropriate capacities developed.

The finding on differences in stroke mortality by sex contradicts results reported from developed nations, and further supports the need for further research on stroke epidemiology in developing countries [21]. Stroke mortality was higher among women than among men. As has been previously demonstrated for other sub-Saharan African countries, there were notable differences in survival, with men surviving longer than women [11, 22].

There is a need, therefore, for (1) strengthening prehospital stroke care to ensure rapid transfer to the hospital and early management; (2) improvement of in-hospital stroke care taking into consideration the established stroke quality-of-care indicators; and (3) investment in poststroke rehabilitation, since the majority of patients may not have access to acute stroke therapy (thrombolysis/device embolectomy) and may end up with severe disability.

Study Limitations

This is a (referral) hospital-based study, and we may not have recruited a representative sample of stroke patients in Kenya, as less severe cases of stroke may not have been admitted or referred for further management (referral bias). Thus, milder forms of ischemic stroke and stroke deaths within the community may have been missed. Our study essentially focused on types of stroke and survival outcome; we did not characterize poststroke functional status. These later observations will be helpful to identify ways forward for rehabilitation. Monitoring of stroke incidence, management, and outcomes across the continuum of care would be the preferred option.

Conclusions

The current findings provide evidence on the stroke burden and outcomes from a low- and middle-income country. Mortality due to stroke is high, with poor survival in the first year after stroke. Men have favorable outcomes compared to women. The risk of death is increased

with increasing age and inpatient status. As a way forward, there is a need to develop customized stroke care protocols and to address quality of care and the long-term needs of stroke patients in Kenya. Public health initiatives aimed at early screening and diagnosis should be advanced. Further research and surveillance are encouraged to establish the true burden of stroke at the community level and to institute mitigation measures.

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Statement of Ethics

The study protocol was approved by the KEMRI Scientific and Ethics Review Committee (SSC No. 2851), the MTRH Institutional Research and Ethics Committee (IREC/2014/213 Approval No. 0001279), and the KNH/University of Nairobi Ethical Review Committee (Study Registration No. MED/029/2015). The study participants gave their informed consent prior to study recruitment.

Disclosure Statement

The authors have no conflicts of interest to declare.

Author Contributions

L. Kaduka and E. Muniu contributed to study conceptualization, implementation, data analysis, and manuscript writing. C. Oduor, J. Mbui, R. Gakunga, J. Kwasa, N. Okerosi, A. Korir, and S. Remick contributed to study conceptualization, implementation, and manuscript writing. S. Wabwire contributed to study implementation and manuscript writing.

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