Article

Case Fatality Rate and Prognosis of Stroke Hospitalized Patients: A retrospective hospital-based study at the Korle Bu Teaching Hospital

Charles Ofei-Palm [1],[*], Anthony Osei [2], Henry Obuobi [2], Daniel Ankrah [3]

[1] Lions International Eye Centre (LIEC), Pharmacy Unit, Korle Bu Teaching Hospital, Accra, Ghana

[2] Drug information Unit, Pharmacy Department, Korle Bu Teaching Hospital, Accra, Ghana

[3] Pharmacy Department, Korle Bu Teaching Hospital, Accra, Ghana

*Correspondence: Charles Ofei-Palm (c.palm@kbth.gov.gh)

Abstract: Introduction: Stroke is associated with high mortality. It is the main neurological cause of mortality and the most important cause of disability worldwide. In the year 2007, Stroke was the third cause of admission at the Korle-Bu Teaching Hospital, and the number one cause of death. **Objective:** To determine the probability of survival (case-fatality rates) of stroke patients admitted at the Korle- Bu Teaching Hospital during the period 2007. **Method:** A Retrospective descriptive study of Surgical/Medical Emergency, SME and the Medical wards admissions and discharges from 1st January 2007 to 31st December, 2007. **Results:** A total of 250 hospitalized stroke patients were identified, of which 68(27%) were from the SME and 182(72%) from the medical wards. The mean age (SD) was 57.6(14.7) and 52% were males. Case fatality rate was 52% at the SME versus 35% at the Medical wards) whilst the risk of death in males expressed as risk ratio (RR) was 2.1, (95% CI 0.70-5.6) vs. RR=1.3, (95% CI 0.73-2.5) in females and the median survival time was 2days (95% CI 1.5-2.4) versus 7 days (95% CI 6.3-7.6) at the SME and Medical respectively. The type of admission and stroke outcome was significant P=0.01 (95%CI 0.02-0.14). **Conclusion:** Stroke was associated with high mortality. The risk of dying from stroke was higher at the SME Findings were independent of stroke subtype, stroke onset and any associated co-morbidities.

Keywords: Case Fatality Rate, Prognosis, Stroke, Hospitalized Patients, Korle Bu, Ghana

1. Introduction

Stroke is associated with high mortality [1]. It is the main neurological cause of death [2] and the most important cause of disability worldwide [3] The World Health Organization (WHO) estimated that death from stroke in developing countries in 2001 accounted for 85.5% of stroke deaths worldwide and the number of disability – adjusted life years (DALYs) which comprises years of life lost and years lived with disability in these countries was almost seven times that of developed countries [4].

Stroke after heart disease, is the second leading single cause of death, with 5.8 million fatal cases per year, 40% of which are in people younger than 70 years. About 15 million people with new acute stroke events arise every year and about 55 million had had a stroke some time in their life either with or without residual disability, two-thirds of these individuals live in developing countries [5].

The global burden of strokes in 2005 was 16 million first ever strokes, 62 million survivors, 51 million DALYs and 5.7 million deaths. It has been suggested that if no additional population–wide suggestions were implemented these figures are predicted

to increase to a staggering 23 million first ever strokes, 77 million survivors, 61million DALYs and 7.8 million deaths by 2030 [6].

Population, aging, [7] demographic changes, urbanization and conventional risk factors such as high blood pressure, smoking, high cholesterol, low fruit and vegetable intake, physical inactivity and alcohol excess are all major contributory factors [8].

Increased salt intake [9-11] exposure to environmental factors, family history studies [12] ecological correlation between low birth weight and risk of later stroke have all contributed to the stroke menace. [13] Others such as genetic factors can act at several levels, they contribute to conventional risk factors such as hypertension ,diabetes or increased homocysteine concentrations [14,15] and they could also affect latency to stroke ,infarct size or stroke outcome [16,17].There have been studies investigating potential risk genes for common multifactorial stroke such as Single - gene disorders ,Cerebral autosomal dominant arteriopathy with sub cortical infarcts and leuconcephalopathy(CADASIL), Fabry's disease, sickle –cell disease, connective tissue disorders most of these are associated with young stroke patients ,children and ischaemic stroke. Their impact on the population is large [18].

Uncontrolled hypertension due to non- compliance to drug therapy with financial constraints to purchase antihypertensive medicines are some of the major reasons of the stroke upsurge according to studies carried out in Ghana [19] and Cameroun [20].

In the year 2007, Stroke was the third cause of admission at the Korle-Bu Teaching Hospital, Ghana's premier hospital, and accounted for 6% of total admission for that year. It was the number one cause of death in the same year accounting for 16% of total causes of death. It is interesting to note that some of the conventional risk factors/predictors associated with stroke namely: diabetes and hypertension, accounted for the first (9%) and fifth (3.8%) causes of admission respectively and were the fifth (4.2%) and seventh (3.6%) causes of death respectively according to the Korle-Bu Teaching Hospital 2007 Annual Report [21].

The risk of all these patients ending up as stroke patients remain very high if proper management and intervention are not taken, hence the burden of stroke seems to be looming in the near future.

The purpose of this study therefore is to find out the probability of survival (case-fatality rates) of stroke patients admitted at the Korle- Bu Teaching Hospital at the Surgical/Medical Emergency Unit (SME Unit) and the General Medical Wards (Medical Wards) during the period 2007.

2. Methods

The Admission and Discharge book (A &D book) of the SME and the medical wards were used for this study. The book provides basic data on patients admitted **to** those wards. Data from 1st January, 2007 to 31st December, 2007 were retrieved for this study.

It provides the following variables as patients' information: Folder number, sex age, occupation, type of ward, date of admission, date of discharge, admission outcome and payments made (cost) per admission. The payments made exclude that of drugs.

2.1. Data Collection

Three trained pharmacists examined the recorded data and identified hospitalized patients with diagnosis of stroke, cerebrovascular accidents, and CVA. Length of stay is calculated as date of discharge minus date of admission.

Due to our limited resources patients were not followed up once they were discharged Instructions for training of staff for data collection were provided in an attempt to ensure quality control. Values missing were either declared missed or discarded, whilst other missing data were inputted-where name is of female or male sex Extreme values were cross-checked with the nurses for consensus decision to be taken.

In general, all potential stroke hospitalized patients were identified by a retrospective case registration. There were no instances that any of the patients were interviewed either before discharge or death. Stroke patients who died or who were discharged at the SME were recorded as SME cases only whilst patients who were admitted at the SME and later transferred to medical wards and were discharged or died were considered as medical ward cases only The identities of the patients were completely anonymous. Therefore, no specific informed consent was signed by the patients.

2.2. Statistical Analysis

The following variables were assessed: age, sex, occupation, type of ward admission, length of stay and admission outcome. Independent t-test (t-test) was used where appropriate to test differences in variables between men and women. The chi-Square (X2 test) was used for categorical variables. As well as to determine associations between some variables and their respective proportions compared. Binary logistic regression analyses were used as appropriated with the unadjusted and the adjusted odds ratio (OR) and clearly reported to indicate the magnitude of the risk factor effect.

In both univariate and multivariate analyses, (OR) and the 95% confidence intervals (CI) were used to estimate the effects of age and sex on the outcome after stroke admissions. For survival analysis, the Kaplan-Meier method was used to determine median survival time. Independent variables such as: ages were categorized in to 6 groups based on the recommendation of the STEPS stroke [22,23]:

<45 years old, 45 to 54 years old, 55 to 64 years old,65 to 74 years old, 75 to 84 years old and ≥85 years old. Occupation was categorized into 3 groups as: employed, unemployed and pensioners. Continuous Variables such as length of stay (days of admission) were converted into the 7 categorical variables: < 24 hours,24 to 48 hours, 49-72 hours, 73 hours -9 days, 10-19 days, 20-39 days, >39 days.

All statistical analyses were performed with SPSS software Package (SPSS Inc, Chicago, III). And statistical significance of 0.05(2-sided)

2.3. Ethical consideration

In this study no patients were interviewed or contacted. Collection of data of patients is a routine process in the hospital. In doing the study all identifiable information of patients such as names of the patients were omitted in the dataset. The threat to patients was therefore minimal and according to the present Standard Operating Procedure of the Ghana Health Service Ethics Review Committee, ethical approval is not deemed necessary for this study [24].

3. Results

A total of 250 stroke patients were identified in both types of admission. 68(27%) at the SME and 182(72%) at medical block as illustrated in Table 1. The highest number of admissions was recorded in the age group, 45-54 years with the lowest recorded in patients aged > 85 years as indicated in Figure 1. More than 66% of individuals had had an event before the age of 65 years at the medical wards compared to 58% in the SME. More women were admitted at the SME than men whilst more men were admitted at the medical wards than women. At the SME, women were found to be averagely older than men; 59 years verses 56 years respectively.
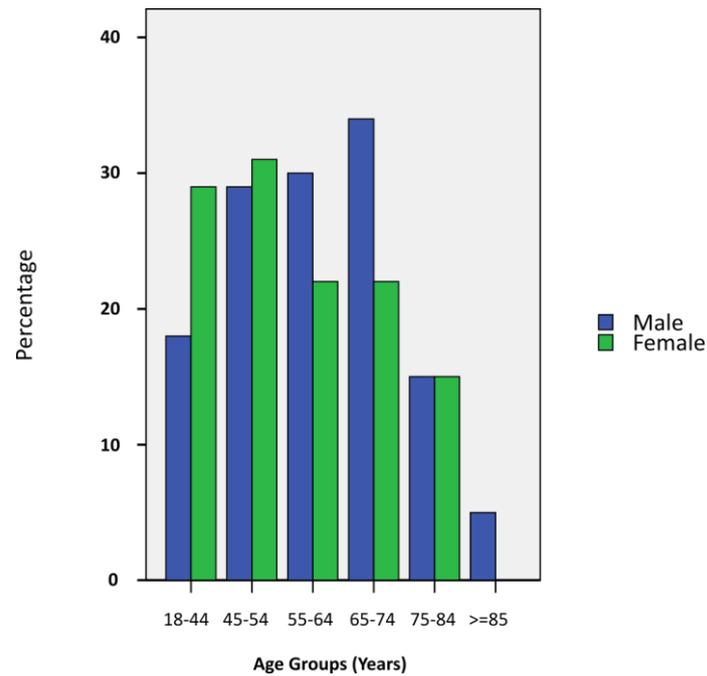
Figure 1. Age distribution of stroke patients.

Table 1. Age distribution and other key variables, by sex, for both SME and medical.

All wards combined (n[%])	Total n=250	Men n=131(53)	Women n=119(47)	*P* value
Age(years)				
Mean(SD)	57.6 (14.7)	59.8(14.3)	54.9(14.6)	*0.014
Median(IQR)	58(47-69)	59(49-70)	54(45-67)	
Range(min-max)	82(18-100)	80(20-100)	65(18-83)	
Age-groups(n[%],years)				
< 45	47(18.8)	18(13.7)	29(24.1)	
45-54	60(24)	29(22.1)	31(26.1)	
55-64	52(20.8)	30(22.9)	22(22.4)	
65-74	56(22.4)	34(26)	22(22.4)	
75-84	30(12.0)	15(11.5)	15(12.0)	
≥85	5(2.0)	5(3.8)	0 (-)	
Length of stay(n[%])				
less than 24 hours	18(7.2)	9(6.9)	9(7.6)	
48 hours	38(15.2)	21(16)	17(14.3)	
72 hours	31(12.4)	12(9.2)	19(14.3)	
4-9 days	102(40.8)	60(45.8)	42(35.2)	
10-19 days	48(19.2)	24(18.3)	24(20.2)	
20-39 days	11(4.4)	4(3.1)	7(5.9)	
≥40 days	29(.8)	1(.8)	1(.8)	
Admission Outcome (n[%])				0.23^
Discharged/alive	151(60.4)	74(56.5)	77(64.7)	
Death	99(39.6)	57(43.5)	42(35.3)	

* Difference between male and female stroke patients. ^ Unadjusted for age and gender

At the medical wards men were much older; 61 years compared to women 53 years. A greater proportion of male admitted of stroke died (44%) compared to female (35%). An association between gender and admission outcome was not significant (p=0.23). The unadjusted odds ratio (OR) for gender is (OR 1.4; 95%CI 0.8 to 2.3) after adjusting for effects of age P=0.21 (OR 0.7; 95%CI 0.4 to 1.2).Our results also indicated there was an association between type of admission and admission outcome (p=0.02). A look at the trend of proportions indicate that a greater number of SME patients died (52%) compared to medical ward admissions (35%). The unadjusted odds ratio for type of admission was(OR 1.9; 95%CI 1.1 to 3.4), after adjusting for the effects of age P=0.02, (OR 0.5, 95%CI 0.2 to 0.9), effects of gender p=0.01, (OR 0.5, 95%CI 0.3 to 0.9).There was no observed association between age-groups and admission outcome (p=0.81).This was contrary to that between length of stay and vital status which observed an association P=0.001, (95%CI 0.001 to 0.01)

3.1. SME

Out of the total of 68 stroke patients admitted at the SME, 35 (52%) died whilst 33(48%) were discharged, a case fatality of 52%. The odds of men dying of stroke whilst admitted at the SME was greater than that of women, the unadjusted odds ratio (OR 2.1, 95%CI 0.70 to 5.6), even though there were more women (58%) admitted than men (42%) as illustrated in table 2. After adjusting for the effects of age (OR 0.4, 95%CI 0.1 to 1.2), the fatality rates amongst the various age-groups are as follows: 67% (55-74 years old), 60 % (75-84 years old), 50 %(< 45 years and ≥ 85 years) and 46% (45-54 years old) respectively.

Table2. Demographic characteristics of SME patients.

SME (n[%])	Total n=68	Men n=39(51.5)	Women n=29(48.5)	*P* value
Age(years)				
Mean(SD)	57.5 (16.62)	58.10(15.5)	55.51(14.6)	**0.42***
Median(IQR)	58(47.5-58)	58(46-70)	55(41.5-70)	
Range(min-max)	73(20-93)	52(28-83)	73(20-93)	
Age-groups(n[%],years)				**0.42*, 0.19^**
less than 45	16(23.5)	9(31)	7(17.9)	
45-54	15(22.1)	5(17.2)	10(25.6)	
55-64	9(13.2)	5(17.2)	4(10.3)	
65-74	16(23.5)	6(20.7)	10(25.6)	
75-84	10(14.7)	2(6.9)	8(20.5)	
≥85	2(2.9)	2(2.9)	-	
Length of stay(n[%])				**0.85*, 0.17^**
< 24hours	12(17.6)	6(20.7)	6(15.4)	
48 hours	21(30.9)	11(37.9)	10(25.6)	
72 hours	13(19.1)	2(6.9)	11(28.2)	
4-9 days	21(30.9)	9(31)	12(30.8)	
10-19 days	1(1.5)	1(3.4)	-	
Admission Outcome (n[%])				**0.20^**
Discharged/alive	33(55.5)	11(37.9)	22(56.4)	
Death	35(48.5)	18(62.1)	17(51.5)	

* Difference between male and female stroke patients. ^ Unadjusted for age and gender

There was no observed association between the various age-groups and admission outcome (p=0.89). A closer look at the trend of proportions in the length of stay indicate that, 92% of patients died within 24hours of admission, 67% died within 48hours of admission and 33% patients died within 72hours of admission with a median survival time of 2 days, (95%CI 1.5 to 2.4)

This trend could be explained by the observed association between length of stay and those who lived or died, P=0.002, (95%CI 0.001 to 0.43). The various distributions for mortality rates among the various medical teams at the SME could not be calculated because 25(37%) of the patients records which would have indicated which medical team had seen them were missing.

3.2. General Medical Wards

182(72%) were identified at the medical ward out of the total of 250 patients. More than (66%) of the patients admitted were younger than 65 years and the highest number of stroke events were recorded in the age groups of 45-54 years as seen from Table 3. More men were admitted than women in all age-groups except those less than 44 years old.

Table3. Age distribution, sex and other variables observed at the General Medical Ward.

General Medical Wards (n[%])	Total n=182	Men n=102(56)	Women n=80(44)	P value
Age(yrs)				
Mean(SD)	57.7(14)	61(13.1)	53.4(14)	**<0.001***
Median (IQR)	58(47.5-68)	62(52-70)	54(43.2-63.7)	
Range(Min-Max)	82(18-100)	76(24-100)	61(18-79)	
Age-groups ([%],years]				**<0.001*, 0.008^**
< 45	31(17)	9(8.8)		
45-54	45(24.7)	24(23.5)	21(26.3)	
55-64	43(23.6)	25(24.5)	18(22.5)	
65-74	40(22)	28(27.5)	12(15)	
75-84	20911)	13(12.7)	7(8.8)	
≥85	3(1.6)	(2.9)	-	
Duration of Stay(n[%]]				**0.20* , 0.61^**
< 24hours	6(3.3)	3(2.9)	3(3.8)	
48 hours	17(9.3)	10(9.8)	7(8.8)	
72 hours	18	109.8)	8(10)	
4-9 days	81(44.5)	51(50.0)	30(37.5)	
10-19 days	47(25.8)	23(22.5)	24(30.0)	
20-39days	11(6)	4(3.9)	7(8.8)	
≥40days	2(1.1)	1(1.0)	1(1.3)	
Employment Status (n [%])				**0.001^**
Employed	107(58.8)	50(66.7)	57(62)	
Unemployed	26(14.3)	18(24)	8(8.7)	
Retired/Pensioner	34(18.7)	7(20.4)	27(29.3)	
Missing	15(8.2)			
Type of Ward (n [%])				**0.97^**
Medical 1	43(23.6)	25(24.5)	18(22.5)	
Medical2	41(22.6)	22(21.6)	19(23.8)	
Medical 3	58(31.9)	32(31.4)	26(32.5)	

Medical 4	40(22)	23(21.3)	17(21.3)	
Vital Status (n [%])				**0.41^**
Discharged/Alive	118(64.8)	63(38.2)	25(31.3)	
Death	64(35.2)	39(38.2)	55(68.8)	

* Difference between male and female stroke patients. ^ unadjusted for age and gender

Looking at the trend of proportions of the 102 male patients admitted at the medical wards, 39(38%) died compared to women 25(32%). Out of the 182 stroke patients admitted on the wards 64(35%) died representing a case fatality rate of 35%.

The distribution pattern of stroke mortality was similar across the various medical wards: 33% medical ward one; 34% medical ward two; 36% medical ward three and 37% medical ward four as illustrated in Figure 2. There was no observed significance difference of mortality amongst the various medical team (p=0.96). Men again had greater odds of dying compared to women according to the unadjusted odds ratio (OR 1.3, 95%CI .0.73 to 2.5) but after adjusting for the effects of age the effect changed (OR 0.8, 95%CI 0.4 to 1.5) and adjusting for the effects of type of work (OR 0.7, 95%CI 0.41 to 1.5).
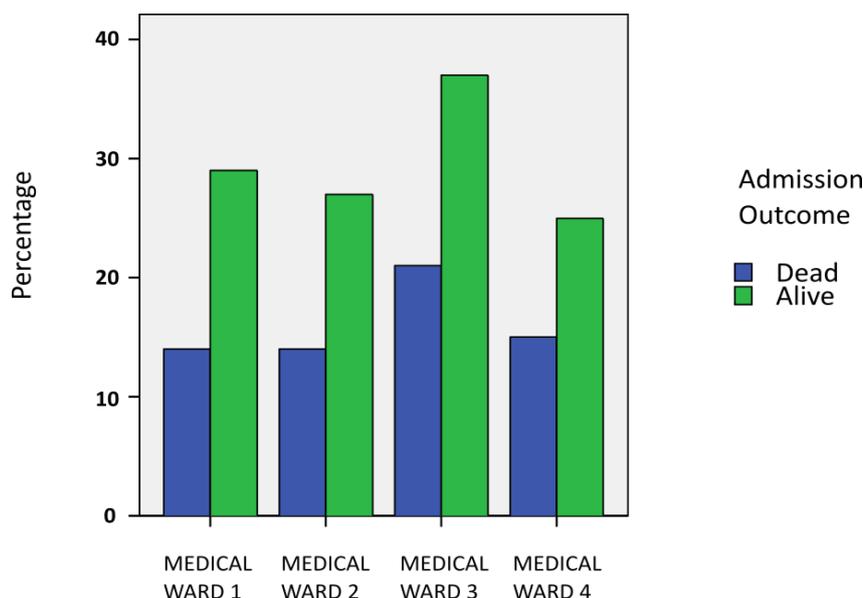

Figure 2. Stroke mortality distribution on the wards.

A higher proportion of stroke patients 27 (85%) died within first the three days of admission at the medical wards compared to those that survived within that period. Five patients who had had only a day of admission died representing a 100% case fatality but the chance of survival increased considerably from 74% (4-9days) to 83% (10-19days), to 78 % (20-39days), 50% (more than 40days). There was an association between length of stay and vital status, p=0.001, (95%CI 0.001 to 0.016).The median survival time for stroke patients on medical wards was 7 days (95% CI 6.3 to 7.6).

Within the type of employment indicated in the A & D book, 107 (59%) of the stroke patients admitted had some sort of employment compared to 34(19%) that were pensioners and 26 (14%) unemployed. But a greater proportion of pensioners (41%) and unemployed (39%) died compared to those employed (32%) There was no observed association between type of employment recorded and admission outcome (p=0.69).

4. Discussion

The mean age of all admitted stroke patients (both SME and medical) in our study was 57.6 years which was much younger compared to studies reported from high income countries, [25-27] but older in studies reported from low-income countries [28,29].

The one-month fatality rates reported separately at both the SME (52%) and the medical wards (35%) were very high compared to the one month case fatality rate reported in other studies [30-32].

In a study conducted in Ghana by Akpalu et al [19] which looked at stroke admissions in the same hospital they reported that case fatalities during these years 1990-1993 was between 41.9% to 50.3%, this reported rate after more than a decade and half is comparatively higher compared to the rate that we recorded at all the wards combined and the medical wards, but slightly lower than case fatality rates recorded at the SME.

In most studies of stroke, men tend to have higher rates of incidence than women, [33-35] a trend quite notable in our study. More women were identified at the SME than the medical wards. This could be due to the fact that because the medical block was under renovation, it was more likely that more women stayed in SME much longer due to the availability of only single ward for that gender at the general wards compared to men that have two wards. Women tend to have lower rates of death than men and this has been demonstrated by our study even though there were more women admitted than men.

4.1. Limitations and Challenges

This study was faced with several limitations. Based on the records we examined, we could not determine the delay in onset of hospitalization. Since the hospital is a referral center it could be that most patients might have been referred and might have spent some length of stay/time at a previous hospital or clinic and upon further deterioration, were referred to the hospital thus contributing to the high case fatality rates recorded in our study.

It cannot be ascertained if the stroke diagnosis found in the A & D book was based on the WHO definition and there has been no study carried out in the hospital to validate the reliability of data written in the A& D book by the nurses. Misclassification bias due to definitions is possible. We therefore assume that this clinical diagnosis is reliable because studies have shown that clinical diagnoses of stroke are usually accurate.

Other challenges of the study were on the recurrence of stroke. In this study that data was missing in the A & D book so it could be possible that some percentage of our patients might have had a history of previous stroke and this might have also contributed to high case fatality rate recorded in our study.

It has been proven in some studies that, some conventional risk factors such as diabetes metabolic syndrome, abdominal obesity, or lifestyles socioeconomic variables, educational level, income, social stress, smoking, stroke disability score and stroke severity could all be significant confounders in the risk for stroke subtypes and predictive factors for death in stroke patients.

This study did not have those data and therefore could not determine its outcome on stroke admission. Heterogeneity of stroke subtype and severity in the analysis of stroke subtype is a strong predictive factor for stroke death. In the study we couldn't tell the various stroke subtypes and severity.

It is also impossible in our mortality data to make accurate distinctions between hemorrhagic and thrombolytic strokes hence our outcome was death or discharged was irrespective of stroke subtype and severity.

The strength of our study lies in the categorization of the various age groups which were done based on the recommendation of the classification by the Steps wise approach. This makes easily comparison to other epidemiological studies on stroke.

5. Conclusion

Our results should therefore be used only to describe the current presentation of patients who are admitted to the Korle-Bu teaching Hospital rather than being translated as an estimate of the burden of stroke in the Ghanaian population.

Admission bias, frequent closures of the SME, non-availability of beds, frequent industrial strikes, and unwritten diagnosis of stroke and possible admissions of stroke to other wards are factors that might have contributed to low admissions and could have underestimated the number of stroke patients reported in our study.

However gathering stroke data provides an important start for prospective surveillance activities. Hospital based studies can only describe the characteristics of such stroke patients and compare the burden of the disorder to other healthcare facilities. Our results can be used to advocate for extra resources for the clinical department concerned.

Stroke is associated with high mortality and furthermore the risk of dying from stroke at the SME is two times greater compared to the medical wards.

References

[1] GBD 2016 Lifetime Risk of Stroke Collaborators, Feigin VL, Nguyen G, et al. Global, Regional, and Country-Specific Lifetime Risks of Stroke, 1990 and 2016. N Engl J Med. 2018;379(25):2429-2437. Doi:10.1056/NEJMoa1804492

[2] Bergen DC, Silberberg D. Nervous system disorders: a global epidemic. Arch neurol 2002; 59:1194-96

[3] Feigin VL, Brainin M, Norrving B. World Stroke Organization (WSO): Global Stroke Fact Sheet 2022 [published correction appears in Int J Stroke. 2022 Apr; 17(4):478]. *Int J Stroke*. 2022; 17(1):18-29. Doi:10.1177/17474930211065917

[4] Mathers CD, Lopez AD, Murray CJL. The burden of disease and mortality by condition: data, methods, and results for 2001.In: Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL, editors. Global Burden of Disease and Risk factors. New Y o r k : Oxford University Press, 2006:45-240

[5] WHO. Preventing Chronic Diseases: a vital investment. Geneva: World Health Organization, 2005

[6] Strong K, Mathers C, Bonita R. Preventing stroke: saving lives around the world. Lancet Neurology 2007; 6:182-87

[7] Strong K., Mathers C., Leeder S., Beagle hole R. Preventing Chronic Diseases: How many lives can we save? Lancet 2005, 366: 1578-82

[8] Aigner A, Grittner U, Rolfs A, Norrving B, Siegerink B, Busch MA. Contribution of Established Stroke Risk Factors to the Burden of Stroke in Young Adults. *Stroke*. 2017;48(7):1744-1751. Doi:10.1161/STROKEAHA.117.016599

[9] Lin CL. Stroke and diets – A review. *Tzu Chi Med J*. 2021;33(3):238-242. Published 2021 Feb 24. Doi:10.4103/tcmj.tcmj_168_20

[10] Hankey GJ. Potential new risk factors for ischemic stroke: What is their potential? Stroke 2006; 37:2181-88

[11] Ezzati M, Vander Hoorn S, Rodgers A, Lopez AD, Mathers CD, Murray CJ, Estimates of global and regional potential Health gains from reducing multiple major risk factors. The Lancet 2003; 362:271-80

[12] Claeys J, Gurvich O, Hadidi NN. Association between Family History of Stroke and Stroke Risk: A Community Survey. *West J Nurs Res*. 2020;42(12):1174-1181. Doi:10.1177/0193945920957935

[13] Lilja L, Bygdell M, Martikainen J, Rosengren A, Ohlsson C, Kindblom JM. Low Birth Weight as an Early-Life Risk Factor for Adult Stroke Among Men. *J Pediatr*. 2021;237:162-167.e4. doi:10.1016/j.jpeds.2021.06.050

[14] López Fernández JC, Rodríguez Esparragón F, Buset Ríos N. Actualización en la genética del ictus [Update on the genetics of stroke]. *Med Clin (Barc)*. 2014;143(4):176-179. Doi:10.1016/j.medcli.2014.02.009

[15] Casas J.P., Bautista L.E., Smith L., Sharma P., Hingorani A.D. Homocysteine and stroke: evidence on a causal link from Mendelian randomization. Lancet 2005; 365:224-32

[16] Simonsen CZ, Leslie-Mazwi TM, Thomalla G. Which Imaging Approach Should Be Used for Stroke of Unknown Time of Onset?. *Stroke*. 2021;52(1):373-380. Doi:10.1161/STROKEAHA.120.032020

[17] Mallolas J., Hurtado O., Castellanos M, et al. A polymorphism in the EAAT2 promoter is associated with higher glutamate concentrations and higher frequency of progressing stroke. J. Exp med 2006; 203: 711-17

[18] Dichgans M. Genetic of ischaemic stroke. Lancet neurol 2007; 6:149-61

[19] Akpalu J, Yawson AE, Osei-Poku F, et al. Stroke Outcome and Determinants among Patients with and without Diabetes in a Tertiary Hospital in Ghana. *Stroke Res Treat*. 2018;2018:7521351. Published 2018 Sep 12. Doi:10.1155/2018/752135120.

[20] Adidja NM, Agbor VN, Aminde JA, Ngwasiri CA, Ngu KB, Aminde LN. Non-adherence to antihypertensive pharmacotherapy in Buea, Cameroon: a cross-sectional community-based study. *BMC Cardiovasc Disord*. 2018;18(1):150. Published 2018 Jul 24. Doi:10.1186/s12872-018-0888-z

[21] Korle-BU Teaching Hospital Annual Report 2007.

[22] Truelsen T, Bonita R, Jamorozik K. Surveillance of stroke: a global perspective. Int Epidemiol 2001 ;(suppl):S11-16

[23] WHO.WHO STEPS Stroke manual: the WHO Stepwise approach to stroke surveillance. Geneva: World Health Organization, 2006. Available At: http://www.who.int/chp/steps/Manual.pdf accessed June 6, 2009.

[24] Ghana Health Service. Ghana health service-ethics review committee: standard operating procedures; 2015. Available from: https://www.ghanahealthservice.org/downloads/Standard_Operating_Procedures.pdf

[25] Accessed August 12, 2022. 25. Heuschman PU, Kolominsky-Rabas PL, Misselwitz B et al. Predictors of in-hospital mortality and attributable risk of death after ischaemic stroke. The German Registers Study Group. Arch intern Med. 2004; 164:1761-1768.

[26] Truelsen T, Heuschmann P U, Bonita R, et al. Standard method for developing stroke registers in low-income and middle income countries: experiences from a feasibility study of a stepwise approach to stroke surveillance (STEPS Stroke).Lancet neurol 2007; 6:134-39

[27] Ong T Z, Raymond AA. Risk factors for stroke and predictors of one –month mortality. Singapore Med j 2002 vol 43 (10):517-521

[28] Akinyemi RO, Ovbiagele B, Adeniji OA, et al. Stroke in Africa: profile, progress, prospects and priorities. *Nat Rev Neurol*. 2021;17(10):634-656. Doi:10.1038/s41582-021-00542-4

[29] Langhorne P, Ramachandra S; Stroke Unit Trialists' Collaboration. Organised inpatient (stroke unit) care for stroke: network meta-analysis. *Cochrane Database Syst Rev*. 2020;4(4):CD000197. Published 2020 Apr 23. Doi:10.1002/14651858.CD000197.pub4

[30] Jaya F. Win MN, Abdullah MR, et al. Stroke patterns in Northeast Malaysia: A Hospital-Based Prospective Study. Neuroepidemiology 2002; 21:28-35(DOI: 1159/000048611)

[31] Walker RW, Rolfe M, Kelly PJ et al. Mortality and recovery after stroke in the Gambia. Stroke 2003; 34:1604-09.

[32] Sene Diouf F, Basse AM, Toure K ,et al. Prognosis of stroke in department of neurology of Dakar, Dakar Medical 2006;51:17-21

[33] Barker-Collo S, Bennett DA, Krishnamurthi RV, et al. Sex Differences in Stroke Incidence, Prevalence, Mortality and Disability-Adjusted Life Years: Results from the Global Burden of Disease Study 2013. *Neuroepidemiology*. 2015;45(3):203-214. Doi:10.1159/000441103

[34] Bonkhoff AK, Schirmer MD, Bretzner M, et al. Outcome after acute ischemic stroke is linked to sex-specific lesion patterns. *Nat Commun*. 2021;12(1):3289. Published 2021 Jun 2. Doi:10.1038/s41467-021-23492-3

[35] Ali M, van Os HJA, van der Weerd N, et al. Sex Differences in Presentation of Stroke: A Systematic Review and Meta-Analysis. *Stroke*. 2022;53(2):345-354. doi:10.1161/STROKEAHA.120.034040