STROKE AT KENYATTA NATIONAL HOSPITAL: SPECTRUM OF IMAGING FINDINGS, AND THE AVERAGE TIME TO INITIAL NEUROIMAGING.

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DECLARATION

I declare that this dissertation is my original work written under the supervision of Dr Chacha Magabe.

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DEDICATION

To Ethel and Hawii: the two little lights that shine the brightest! And to my loving Mum and siblings, the custodians of all my strength.

ACKNOWLEDGEMENT

My gratitude goes to my supervisor, Dr Chacha Magabe, for his patient tutelage during the writing of this dissertation. I am also indebted to the staff at the CT unit at Kenyatta National Hospital for their unflinching support during data collection. To my able assistants, Hilda and Rhoda, thank you, and good luck as you draw nearer writing your own dissertations!

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LIST OF ABBREVIATIONS

ASPECTS	Alberta Stroke Program Early CT Score
CBF	Cerebral blood flow
CBV	Cerebral blood volume
CDC	Centres for Disease Control
CPP	Cerebral perfusion pressure
CT	Computed tomography
CTA	CT angiography
CTP	CT perfusion
DSA	Digitally-subtracted angiogram
DM	Diabetes mellitus
DWI	Diffusion-weighted imaging
FLAIR	Fluid attenuation and inversion recovery
HTN	Hypertension
ICeH	Intracerebral haemorrhage
KNH	Kenyatta National Hospital
LOCM	Low osmolar contrast media
MCA	Middle cerebral artery
MDCT	Multidetector row computed tomography
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
MTT	Mean transit time
NCD	Non-communicable disease
NECT	Non-contrast enhanced computed tomography
PWI	Perfusion-weighted imaging
RBC	Red blood cell
r-tPA	Recombinant tissue plasminogen activator

T1W	T1-weighted
T2W	T2-weighted
WHO	World Health Organization

ABSTRACT

Background

Varying proportions of stroke subtypes are reported in literature. The most common reported in Kenya is ischemic stroke, ranging 52-85% on CT. Additionally, poor stroke functional outcomes and high mortality rates have been documented. No local studies have examined the time delays stroke patients experience before receiving care.

Objective

To describe the spectrum of cranial CT findings in patients presenting for imaging with a clinical suspicion of stroke, to estimate the average time between symptom onset to initial imaging and investigate the 60-day outcomes of ischemic stroke.

Materials and methods

The study was prospectively conducted at Kenyatta National Hospital from November, 2017 to April, 2018. Consecutive 106 patients with clinical suspicion of stroke referred for imaging were recruited. CT scans were acquired as per the institutional protocol. Clinical and radiological follow up after 60 days were carried in the subgroup of patients who had ischemic stroke.

Results

Stroke accounted for 42.4% of all findings, the majority being ischemic stroke (55.6%). Stroke mimics were seen in 18% of patients. The mean time to imaging was 70.8 hours, with none of the patients being eligible for thrombolysis. The 60-day ischaemic stroke outcomes showed predominant neurological deficits of residual limb weakness (48%) and recurring convulsions (16%). The mortality and symptomatic improvement in this subgroup were similar at 8%.

Conclusion

Cerebral infarction was the commonest stroke subtype. There was a greater percentage of stroke mimics such as intracranial masses and infections. The mean time from symptom onset to imaging was long, with none of the patients receiving thrombolytic therapy. The 60-day outcomes in the ischemic stroke subgroup was poor.

CHAPTER ONE

Introduction and literature review

Various local and regional investigators have studied the imaging patterns of stroke. However, there exist significant differences in the methodologies used and the parameters studied. Most of the studies are retrospective and focused on the risk factors and 90-day hospital outcomes of stroke. None of the studies reviewed in Kenya focused on the time lapse between neurological symptom onset and presentation for neuro-imaging and treatment - established prognostic factors.

In 2006, Thiringi et al(1), showed that ischemic stroke was commoner, accounting for 68.1%. This study was based at two private establishments- a hospital and a day imaging centre. Notably, only black patients were included. Despite providing a local data set, the findings from this study may differ from observations at Kenyatta national hospital, a high volume national referral public hospital.

A retrospective study of stroke based at KNH reviewed the cerebral cortical anatomic distribution of ischemic stroke alone(2). This was a hospital records analysis of more than 300 stroke patients managed at KNH in a five-year period (January 2007- December 2011). It also considered the co-morbidities and outcome after three months. Similarly, only black patients were included in this study. Besides similar risk factor profiles, the study does reveal patient outcomes comparable to other African studies conducted under similar low resource settings. For instance, the 90-day mortality was 12.1%, and residual neurological deficits (paralysis) was high (65.1%). Notably, the study did not consider other non-ischemic strokes (cerebral haemorrhage and sub-arachnoid bleed) and stroke interventions such as thrombolysis, both pharmacologic and mechanical.

At Moi Teaching and Referral Hospital, Kenya, a study of 155 patients admitted with stroke (January, 2010 – December, 2014), found a slight majority of strokes (52%) to be haemorrhagic. About 73% of the patients were hypertensive, leading to this disparity compared to the generally observed trend where ischemic strokes are commoner. It revealed an 84% access rate to neuroimaging (CT scan) by the first day of admission. There was no report of the rate of eligibility for thrombolytic therapy in patients with ischaemic stroke(3).

In a retrospective study of 80 stroke patients at Nairobi Hospital (an urban private hospital) in 2008, it was noted that ischemic stroke was the most common stroke subtype, accounting for 85% of the cases. This study did not report on the rate of eligibility and use of thrombolytic treatment in the patients with ischemic stroke. Overall, the in-hospital prevalence of stroke was 3042/100,000 (4).

In a tertiary teaching hospital in Port Harcourt, Nigeria, Onubiyi and colleagues described the patterns of CT findings in 203 stroke patients. Ischemic strokes accounted for 63.2% of all the cases. The patient age distribution was wide, ranging 6-90 years, possibly leading to a wider risk factor spectrum(5).

In a four-year prospective study of 1326 incident stokes in Northern Italy, ischemic strokes accounted for 79.7% of stokes. The proportions of acute intracerebral haemorrhage and sub-arachnoid bleeds were 11% and 3.3% respectively. The median time from symptom onset to CT scan was 5.4 hours, falling slightly out of the therapeutic window of 3.5 hours for safe IV thrombolysis of ischemic stroke. The neuroimaging protocol differed from the local studies, with about 50% of the patients undergoing a brain MRI scan in the course of their admission. Patients presenting with seizures were excluded from this study(6).

Stroke mimics are important clinical differential diagnoses of stroke, and have been observed to contribute up to 30% of the imaging findings in some studies. In an analysis of acute stroke mimics in 8187 patients referred to the NIH stroke service in the USA, female gender, younger age and the absence of risk factors such as hypertension were noted to be important predictors of the imaging finding of stroke mimics and normal studies(7). Studies estimating the population incidences of stroke employ strict risk factor profiling and active surveillance to minimize the inclusion of patients unlikely to suffer from stroke.

The 2013 global burden of disease estimated that there were about 25 million stroke survivors, more than 6 million deaths due to stroke and more than 100 million disability adjusted life years (DALYs)(8). There were more than 10 million incident strokes over the same period. The study found a greater disease burden of stroke in the developing countries which accounted for 75.2% of the stroke deaths and 81% of the DALYs related to stroke. Also noted was an overall increase in the proportional contribution of stroke to DALYs and deaths during the period spanning 1990- 2013. While remaining unchanged in the developed countries, the DALYs and deaths due to stroke have increased in the developing countries, especially in Sub Saharan Africa. The grim statistics can be attributed to the lack of comprehensive stroke care programmes, and dedicated acute stroke response units especially in public hospitals.

Improved diagnosis and treatment of stroke has led to improved patient functional outcomes in terms of mobility, ability to communicate, cognitive functioning and socialization. However, these benefits have been largely felt in the developed countries. Kenya, along with other developing nations continue to grapple with poorer stroke outcomes.

The clinical outcomes of stroke depend on the time lapse between the ictus and the institution of appropriate care, and other case-specific prognostic factors. These include patient age, size of infarct core and the region of the brain affected. In a Nigerian study, none of the 83 stroke patients presented to hospital within 3 hr, and therefore were ineligible for thrombolysis. The mean time of presentation was long, averaging 70 hr(9).

Evidence from multiple trials consistently shows improved outcomes of thrombolysis in acute ischemic stroke within 3 hours. In a multi-trial pooled analysis, Kennedy RL et al demonstrated improved outcomes with treatment delays up to 4.5 hours, although greater benefits were conferred within 3 hours using recombinant tissue plasminogen activator (r-tPA). No published local experience with the use of r-tPA for initial stroke thrombolysis was found. International trials have demonstrated safety, efficacy and improved patient functional outcomes using mechanical thrombectomy. For instance, a meta- analysis of data from various trials utilizing the Solitaire™ device showed a revascularization success rate of 77%. Mechanical thrombectomy alone, or in combination with intra-arterial r-tPA was found to be safe for up to 6 hours post-ictus therefore extending the therapeutic window for stroke intervention(10).

The quality of stroke care in a country can, at least in part, be described using data on how rapidly patients with stroke symptoms access essential initial medical care, the availability of rapid response stroke units, and treatment outcomes. One Canadian study used the rate of thrombolysis in ischemic stroke as a marker of the quality of stroke care. In this retrospective cohort study, the rate of thrombolysis was found to be low (6.1%). The low rate was attributable to delays in both patient arrival and in-hospital decision making for neuroimaging and administration of thrombolysis(11).

In Kenya, the studies describing CT findings in stroke patients did not report the time lapses between symptom onsets to first imaging. Moreover, there is a general lack of data describing the quality of stroke care in the country. Given the general challenges of rapid access to specialized healthcare in the country, it is anticipated that patients who experience cerebrovascular events are likely to experience significant delays before getting the required clinical, diagnostic and, possibly, therapeutic services including thrombolysis for ischemic stroke(12).

CHAPTER TWO

Definition of stroke

Stroke is defined as the clinical event of a sudden onset of neurologic deficit secondary to cerebrovascular disease. Most investigators classify stroke into three pathologic subtypes. These are ischemic stroke, haemorrhagic stroke and non-traumatic sub-arachnoid haemorrhage (SAH). The estimated proportions are 80%, 15% and 5% respectively. Other authors consider cerebral venous infarction, estimated to account for a small minority of cases, about 1%(13).

1. Ischaemic stroke

Pathogenesis: the infarct core and penumbra model.

Ischemic stroke occurs when the perfusion of a region of the brain is critically reduced resulting in a physiological cascade that leads to neuronal death. Cerebral blood flow (CBF) is tightly auto regulated(14). It ranges between 50-55 ml of blood per 100 grams of brain tissue per minute. The volume of blood within the stated volume of brain tissue (cerebral blood volume, CBV) depends on the rate of arterial inflow and venous outflow.

The physiologic response to reduced cerebral perfusion pressure (CPP), for instance due to thrombotic arterial occlusion, involves vasodilatation and recruitment of collateral blood vessels to reduce resistance to flow, thus increasing the CBV and maintaining the CBF.

Consequently, the amount of time a red blood cell (RBC) spends within a given volume of brain tissue- the mean transit time (MTT) - depends on the degree of autoregulation of the CBF. The MTT is typically raised in viable auto regulated brain tissue.

The currently accepted pathophysiologic model of cerebral infarction is based on the above concept. It is premised on the recognition that following acute cerebral arterial occlusion, there is a non-uniform decline in the regional CBF of the affected brain tissue.

The infarct core is the (central) region of very low CBF. It is therefore irreversibly infarcted and nonviable. The neurons in this focus are depolarized. A surrounding peripheral zone, the penumbra, has moderately diminished CBF. It contains neurons that have lost electrical function but are otherwise viable. The cells in this region are potentially salvageable by a timely restoration of the CBF by vascular recanalization. A more peripheral ‘zone of benign oligaemia’ is also defined beyond the penumbra. Here, the CBF is only mildly reduced and the neural tissue is the most likely to survive the ischaemic insult (figure 1).

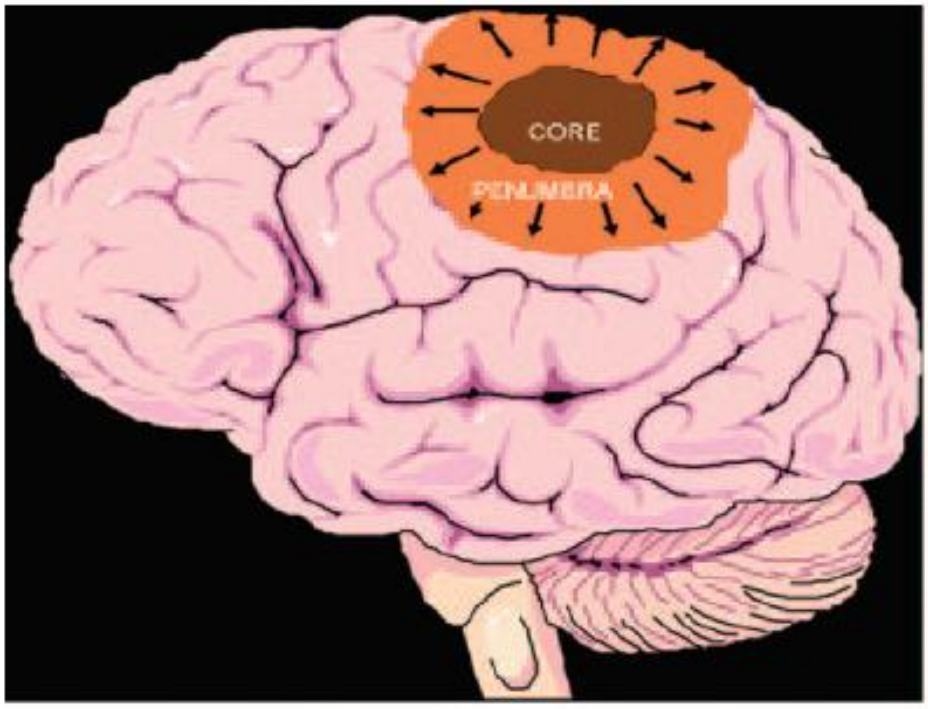


Figure 1: Sagittal graphic depicting the concept of infarct core and penumbra.

Adapted from Ashok S et al; State-of-the art imaging of acute stroke. Radiographics 2006; 26:S75–S9.

2. Haemorrhagic stroke

The most common aetiology for intracerebral haemorrhage is hypertension. Other causes include cerebral amyloid angiopathy, trauma and haemorrhagic vascular malformations. Haemorrhagic transformation of ischemic stroke is a distinct pathologic entity that results from reperfusion, occurring spontaneously or following vascular recanalization and thrombolysis. Additionally, haemorrhagic primary or metastatic tumours may be the cause of intracerebral bleeds. Intracerebral bleeds undergo a relatively predictable temporal evolution. The imaging findings therefore will depend on the stage of the hematoma. Thus, bleeds are categorized as hyperacute, acute (early and late), subacute and chronic based on their T1 and T2 MRI signals.

3. Non-traumatic subarachnoid haemorrhage

This is the presence of blood in the subarachnoid space, often due to a raptured cerebral arterial aneurysm. The secondary effects of vasospasm and direct neurotoxicity have been hypothesized to contribute to the morbidity and poor clinical outcomes(15).

Stroke symptoms.

Stroke symptoms are attributable to dysfunction, or loss of function of the regions of the brain affected during the cerebrovascular event. The spinal cord, less commonly, can be affected by an acute vascular event leading to development of specific clinical symptoms and signs. Effects of acute disruption of blood flow to the retina can lead to temporary or permanent loss of vision, a separate but closely related event known as amaurosis fugax(16).

Population-based studies of incident stroke symptoms list headache, gait disturbance, convulsions and vertigo as the most frequent symptoms. Elicited clinical signs include hemiparesis or sensory deficits, visual and speech disturbances. In an epidemiological analysis of the findings from the "ARIC" Study(17), limb weakness/ paresis was the most reported symptom (81.6%). Headache and gait disturbances occurred in 27.4% and 10.8% of the 474 cases respectively.

Defining the time of stroke symptom onset

The time lapse between stroke onset and patient presentation to hospital is the single most important determinant of eligibility for pharmacologic and/ or mechanical thrombolysis. Therefore a fairly accurate definition of stroke onset is of clinical significance. However, this definition is frequently elusive in practise since it often depends on a witness to the patient's symptoms.

Patients who remain coherent are asked to recall the time of symptom onset. Additionally, witness accounts are sought to clarify the last time the patient was seen well. A major limitation in relying on witness accounts is in patients who suffer unwitnessed strokes or those who wake up symptomatic. Potentially, patients who would otherwise benefit from thrombolysis may be erroneously excluded from treatment.

The review article by Ona Wu et al(18) highlights the potential utility of advanced imaging with CT and MRI to objectively estimate the time of stroke onset. The use of these novel techniques, if adopted in the diagnostic work up of stroke, would increase the number of patients eligible for thrombolysis based on the criterion of time of onset.

Diagnosis of stroke: The current imaging paradigm

Neuroimaging forms the cornerstone of diagnosis and treatment decision making in acute stroke. CT scan and MRI are the imaging modalities that provide the most relevant information in neuroimaging for suspected stroke. Every emphasis is placed on rapid patient assessment, with the initial aim of distinguishing haemorrhagic from ischemic stroke. At the same time, alternate aetiologies that could explain the patient's neurological symptoms are sought. These could include, among others, primary or metastatic brain tumours, or even reversible cerebral vasospastic disorders.

While CT has remained integral to the diagnosis of stroke, the appreciation of its limitations in the hyperacute setup has led to the emergence of MRI as a more sensitive modality. The introduction of perfusion imaging (using CT or MRI) have revolutionized the imaging of tissue at risk besides the infarct core(19). These newer techniques provide stronger evidence for the administration of thrombolytic drugs as well as mechanical thrombectomy.

The imaging findings of stroke are mainly determined by the pathologic subtype of stroke as well as the time lapse between stroke neuroimaging. The imaging signs undergo a fairly predictable temporal evolution. For instance, ischemic cerebral parenchymal changes detected at CT range from inconspicuous, often unconvincing, reduced cerebral CT attenuation during the hyper acute phase to obvious regional (territorial) hypodensities after 12-24 hr due to cytotoxic oedema (20).

Imaging protocols, and the choice between CT and MRI for the imaging of acute stroke, vary among institutions. This choice is often influenced by the availability, technology/software, time of stroke, physician expertise, and the possibility of neuro-intervention.

CT scan is more widely available and cheaper than MRI. It is also frequently available for use during off-shift hours. As well, CT images are rapidly acquired and therefore ideal in emergency settings. A non-enhanced CT (NECT) reliably excludes intracranial haemorrhage. In cerebral ischemia, CT detects acute thrombosis in major cerebral arteries such as the middle cerebral artery (MCA). A dense artery sign is the earliest detectable change on CT, and can be seen at the onset of the neurological symptoms.

Despite its wider application for stroke imaging, CT has a low sensitivity for the detection of cerebral parenchymal changes in hyperacute to acute stroke. There is absence of obvious parenchymal changes in 50–60% of NECT within 2h of stroke onset. The sensitivity of CT for the detection of infarcts in acute stroke has been reported to range from just 30% at 3 hours and 60% at 24 h. The high false negative rate limits its application in the choice for urgent IV thrombolysis, which is recommended within 3- 4.5 hr within stroke onset(21).

Cerebral CT angiography (CTA) is an adjunctive technique that can be performed immediately before the patient leaves the imaging department. This depends on prompt review of the NECT images by a radiologist. It involves the intravenous injection of about 100 ml of iodinated contrast, and scanning from the aortic arch to the circle of Willis(22).

CTA outlines the cervical and intracranial cerebral arteries. With suitable multiplanar reconstructions, superb anatomic depiction of the arteries is achieved. Vascular occlusions are therefore detected if any. The coverage of the cervical segments of the carotid and vertebral arteries allows the diagnosis of arterial thrombosis or stenosis that could be the aetiology of cerebral infarction.

Most authors agree that MRI is sensitive for the diagnosis of hyperacute stroke. For instance, MR DWI can detect acute stroke within 30 minutes of stroke onset(23)(24). However, MRI has not been locally adopted for acute stroke imaging due to restricted availability during off shift imaging.

Perfusion imaging

Perfusion imaging can be performed using either CT(25) or MRI(26). Both modalities assess the blood flow within a selected region of the brain (‘the region of interest’) using mathematically derived analysis of three basic physiologic parameters, namely the cerebral blood flow (CBF), cerebral blood volume (CBV) and the mean transit time (MTT).

Perfusion parameters essentially define the infarct penumbra if present. At CTP, a penumbra is present when there is a mismatch between the CBV and CBF. A matched decrease in CBV and CBF represents the unsalvageable ischemic core. The detection of a penumbra validates the use of recanalization therapy, such as intra-arterial or intravenous thrombolysis in patients presenting within the 3- 4.5 hr window.

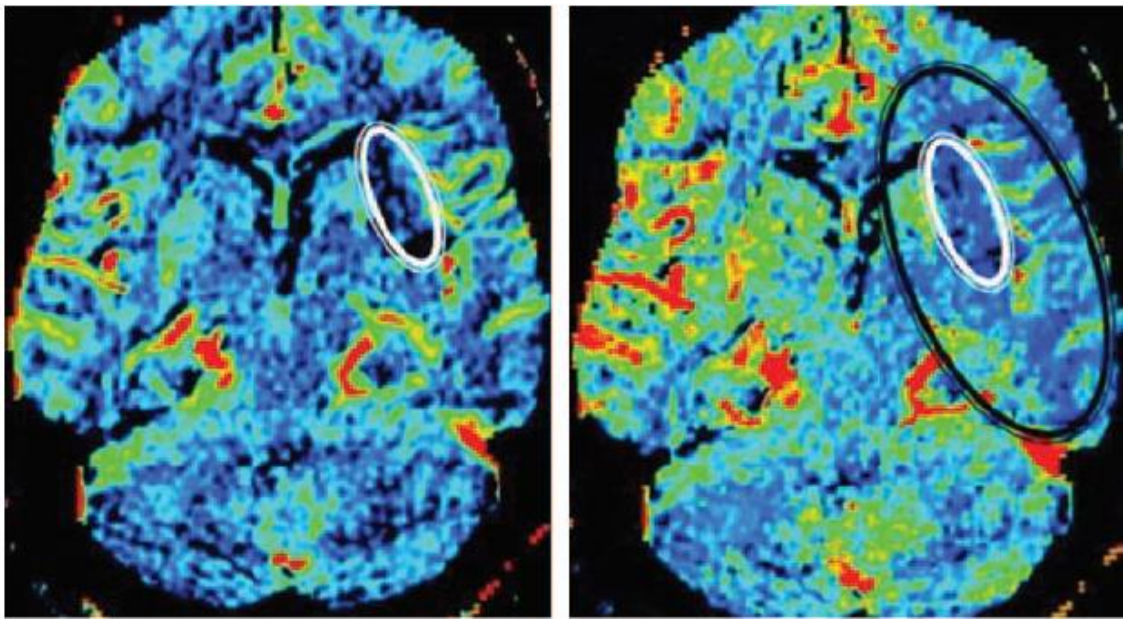


Figure 2: Axial CT perfusion CBF and CBV maps showing an infarct core (small inner oval) and penumbra represented by the larger outer oval (right). **From Ashok S et al; State-of-the art imaging of acute stroke, Radiographics 2006; 26:S75–S9.**

Treatment of Stroke- thrombolysis

The use of thrombolytic drugs is established in the treatment of acute stroke. The main determinant of the safe administration of these drugs is early patient presentation within the safe window of 3- 4.5 hours after onset of stroke symptoms. Prompt institution of treatment can restore circulation to the brain and thus avoid the detrimental effects of irreversible brain damage. An example of the drugs licenced for this clinical application is intravenous (IV) recombinant tissue plasminogen activator (r-tPA), alteplase. The efficacy and safety of alteplase has been extensively studied, and there is consensus that its use within the recommended time window is better than placebo(27)(28).

Besides presentation after 3- 4.5 hours, the other contraindications to the administration of thrombolytic treatment are the presence of intracerebral bleeding occurring primarily, or as a transformation of ischaemic stroke, and large infarct size greater than 1/3 of the affected MCA territory.

There is sufficient clinical evidence for mechanical clot retrieval in the setting of neurovascular intervention for up to 6 hours after stroke onset. An example is the use of the Solitaire™ device. Given, the strict criteria for pharmacologic thrombolysis, this forms a viable alternative in settings where patients would be likelier to present later for imaging and treatment.

CHAPTER THREE

Study justification

The cost of stroke care is a huge financial burden. No estimates of the economic costs of stroke are available locally. In the United States, the estimated annual expenditure on stroke is approximately $34 billion for the health care services, medications, and days of work missed. In Kenya, this would constitute a major economic burden given a comparatively low current per capita expenditure on health, estimated at $169(29). At the same time, the country lacks a comprehensive stroke care programme, including dedicated acute stroke response units in public hospitals. Compounding this is the lack of systematic audits of the quality of care offered to stroke patients, such as public stroke literacy levels and the rate of thrombolysis for ischemic stroke(30).

Acknowledging the existence of related studies, this study aims to prospectively evaluate the radiological patterns of findings in patients with clinically suspected stroke. Additionally, the time delay, and 60-day treatment outcome of ischemic stroke will be assessed.

Hypothesis

Patients with stroke symptoms present to Kenyatta national hospital after 3.5 hours since the onset of their symptoms.

Study question

What is the spectrum of imaging findings in patients with stroke symptoms referred for neuroimaging at Kenyatta National Hospital?

Broad objective

To determine the spectrum of cranial CT findings in patients with symptoms of stroke at Kenyatta National Hospital.

Specific objectives

1. To describe the CT findings in patients undergoing imaging for suspected stroke.
2. To estimate the average time from stroke symptom onset to initial neuroimaging.
3. To document the 60-day clinical outcomes of ischemic stroke at Kenyatta National Hospital.

Study design and methodology

Cross-sectional descriptive study.

Study sites

1. Department of Radiology, Kenyatta National Hospital.
2. The in-patient wards where the study participants are admitted.

Study population

All consenting consecutive patients with clinically suspected stroke with radiological requests for neuroimaging at the radiology department, Kenyatta National Hospital.

Study period

The study was conducted over 6 month's duration from October, 2017 to March, 2018.

Personnel

1. The principal investigator
2. A consultant Radiologist with a bias to interventional radiology.
3. A biostatistician (study design and data analysis).
4. Trained data clerks.

Participants

Inclusion:

1. Patients consenting for inclusion in the study.
2. Patients with clinically suspected cerebrovascular accidents sent for brain imaging at the Radiology Department, Kenyatta National Hospital.
3. Patients unable to give individual consent as long as relatives/guardians give informed consent.

Exclusion:

1. Patients with known history of cranio-facial trauma
2. Patients with known pre-existing intracranial space occupying lesions (SOLs).

Sample size calculation

The Cochran formula for estimating sample size in prevalence studies was used with a finite population correction as recommended by Daniels WW (1999).

$$n = \frac{NZ^2P(1-P)}{d^2(N-1) + Z^2P(1-P)}$$

N = the population of patients with suspected stroke in KNH undergoing CT imaging during the projected study period. Using data on the average monthly investigations conducted in the radiology and imaging units this population was estimated at 180 for the proposed data collection period.

P = Prevalence of abnormal imaging findings reported in scans of patients with stroke in African studies estimated at 78.3% in a Nigerian public tertiary hospital similar to KNH.

1-P = 1 minus the prevalence of abnormal imaging findings reported in CT scans of patients with stroke

Z = Z statistic representing 95% level of confidence (1.96)

d = desired level of precision set to 0.05

$$n = \frac{180 \times 1.96^2 \times 0.783(1-0.783)}{0.05^2(180-1) + 1.96^2 \times 0.783(1-0.783)}$$

n = 106.

Therefore, a total of 106 patients were recruited.

Ethical consideration

Ethical clearance to conduct the study was obtained from the KNH/ UoN ERC, proposal number P289/05/2017. Institutional permission was sought from the University of Nairobi, KNH department of radiology and the respective inpatient wards where the patients were admitted.

There was no active recruitment of study participants. Only patients meeting the clinical criteria for neuroimaging for suspected stroke or cerebrovascular accidents were considered. Written informed consent was sought from the patients meeting the study inclusion criteria. The consent form included the rights of the participants.

All data collection sheets were anonymized. Each study participant was allocated a unique numerical code that was used in data abstraction. Confidentiality of participants was maintained throughout the study.

Materials and methods

Cerebral CT images were acquired using the Siemens SOMATOM Definition AS+ 128-slice CT scanner at the radiology department in KNH. Initial non-enhanced CT scans were acquired to differentiate haemorrhage from ischemia. Images were reviewed at the PACS work station and the findings recorded in data collection forms. Appropriate windowing was applied and all processed and reformatted images were recorded on DVD and stored on an external hard drive. Photographs depicting the findings were entered in a table on the data collection form (appendix 5). Infarct size was scored as per the Alberta Stroke Program Early CT Score (ASPECTS) methodology(31).

Patients with imaging findings requiring further characterization underwent contrast-enhanced studies using the following protocol: 80 ml of low-osmolar contrast media (300mg/ml) via pump injector at a rate of 5ml/second through an antecubital vein cannula (at least gauge 20) with a delay time of 7 seconds. For patients <50 kg, a dose of 2ml/kg of contrast was used.

Patients' clinical notes were reviewed and the following information extracted: Duration of symptoms before presentation to hospital and the prescribed treatment for ischemic strokes. Follow-up clinical and radiological reviews to determine clinical outcome were carried out with patients who had ischemic strokes 60 days after they underwent the CT scans. Data collection sheets were used to record biodata, relevant clinical and imaging for each participant. Data analysis was done using Statistical Package for Social sciences Program (SPSS) version 20.0.

Main outcome measures

The average time from stroke symptom onset to initial imaging was calculated and reported with its range. To describe the initial spectrum of imaging findings in stroke, number of patients presenting with each of the main findings was counted and percentages calculated using all recruited patients as a denominator. Statistical tests including chi square was used to compare proportion of patients with various neuroimaging findings and clinical presentation. All the statistical tests were conducted at a significance level (alpha) of 0.05.

Data quality management

Data was collected from patient interviews and through review of both medical records and CT scans. The principal investigator and data clerks trained on appropriate techniques for conducting semi structured interviews and abstracting required data from medical records. Prior to the study, the PI reviewed and became conversant with common abnormalities on CT scans associated with stroke.

During the study, all CT scan images were reviewed independently by the PI and a consultant radiologist to confirm the spectrum of findings. Consensus was sought in instances where the PI felt that he was not confident about interpretation of images.

On completion of each questionnaire, the principal investigator examined all items for completeness. Data was entered into databases designed in SPSS IBM (version 20). Data cleaning and analysis was then conducted. Any inconsistency between the questionnaire and data contained in the database was resolved by checking patient records and re-entering the data contained in the records.

All the data was archived in a secure lockable cabinet and retained until the end of the study and thereafter after publication of the study findings.

CHAPTER FOUR

RESULTS

Demographics

The participants' age range was wide, between 20-87 years. The median age was 54 years. Most patients (56.7%) were aged 50 years and above. The male-to-female ratio was 1:1.2 (figures 3 and 4).

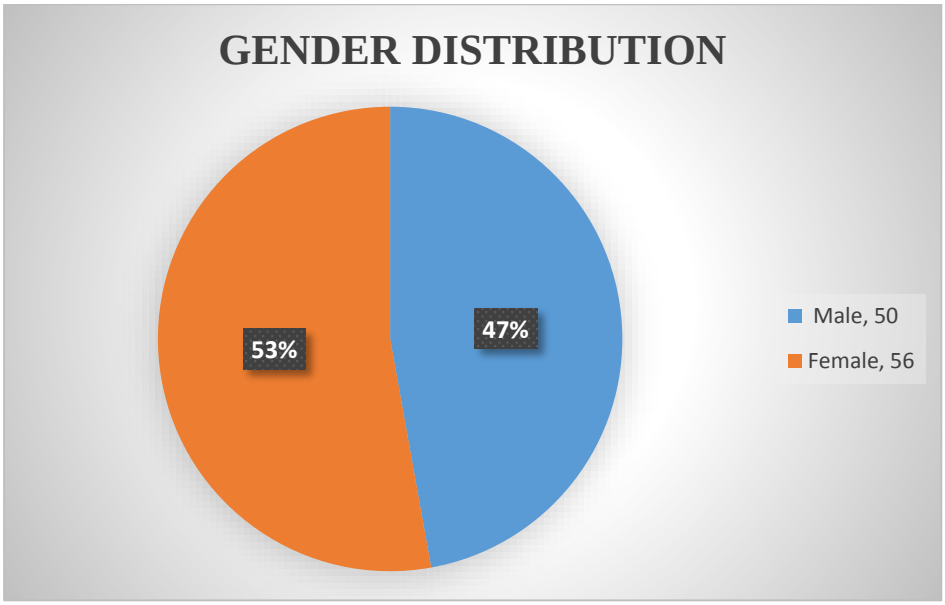


Figure 3: Pie chart showing the gender distribution of patients.

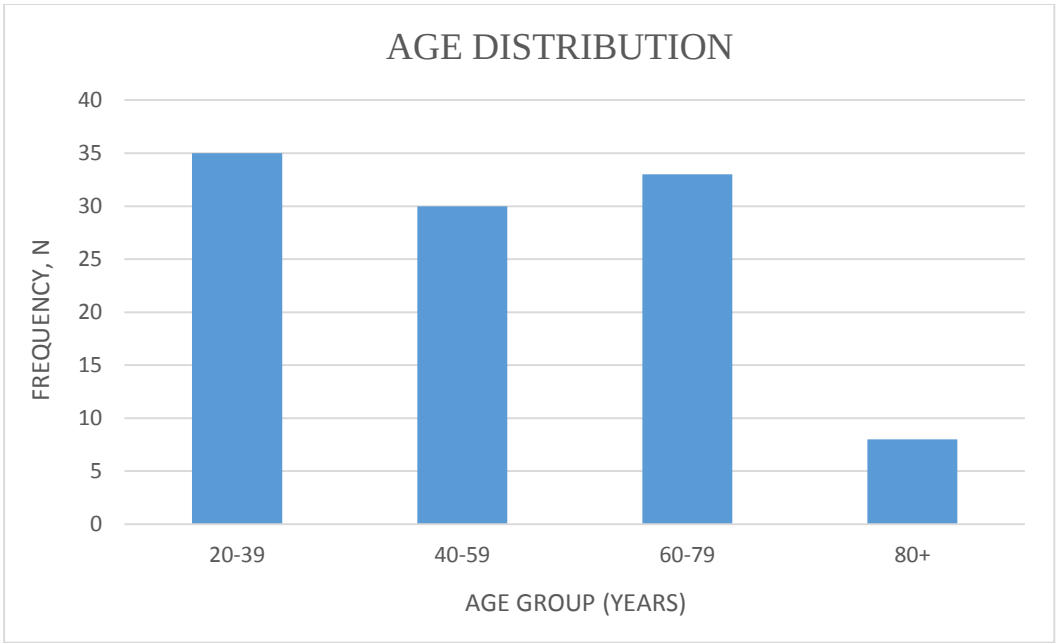


Figure 4: Graph showing the age-group distribution of patients.

Clinical symptoms

The reported clinical symptoms were varied. Most patients (47%) complained of paralysis prompting the clinical suspicion of stroke. The least reported symptom was numbness (figure 5). There was significant statistical association between limb weakness (paralysis) with the imaging finding of stroke (p 0.004) (table 1).

Table 1: Table showing the association between the clinical symptoms and stroke.

		Imaging finding, N		Chi-statistic	*p* value
Symptom		Stroke	Not stroke		
Limb weakness	Yes	29	19	8.20	0.004
	No	19	39		
Headache	Yes	4	16	6.37	0.012
	No	44	42		
Convulsions	Yes	4	9	2.02	0.155
	No	44	49		
Loss of consciousness	Yes	7	8	0.01	0.495
	No	41	50		
Sudden collapse	Yes	1	3	0.67	0.413
	No	47	55		
Confusion	Yes	2	1	0.57	0.450
	No	46	57		
Aphasia	Yes	1	0	1.13	0.288
	No	47	58		
Numbness	Yes	0	1	1.58	0.209
	No	48	57		

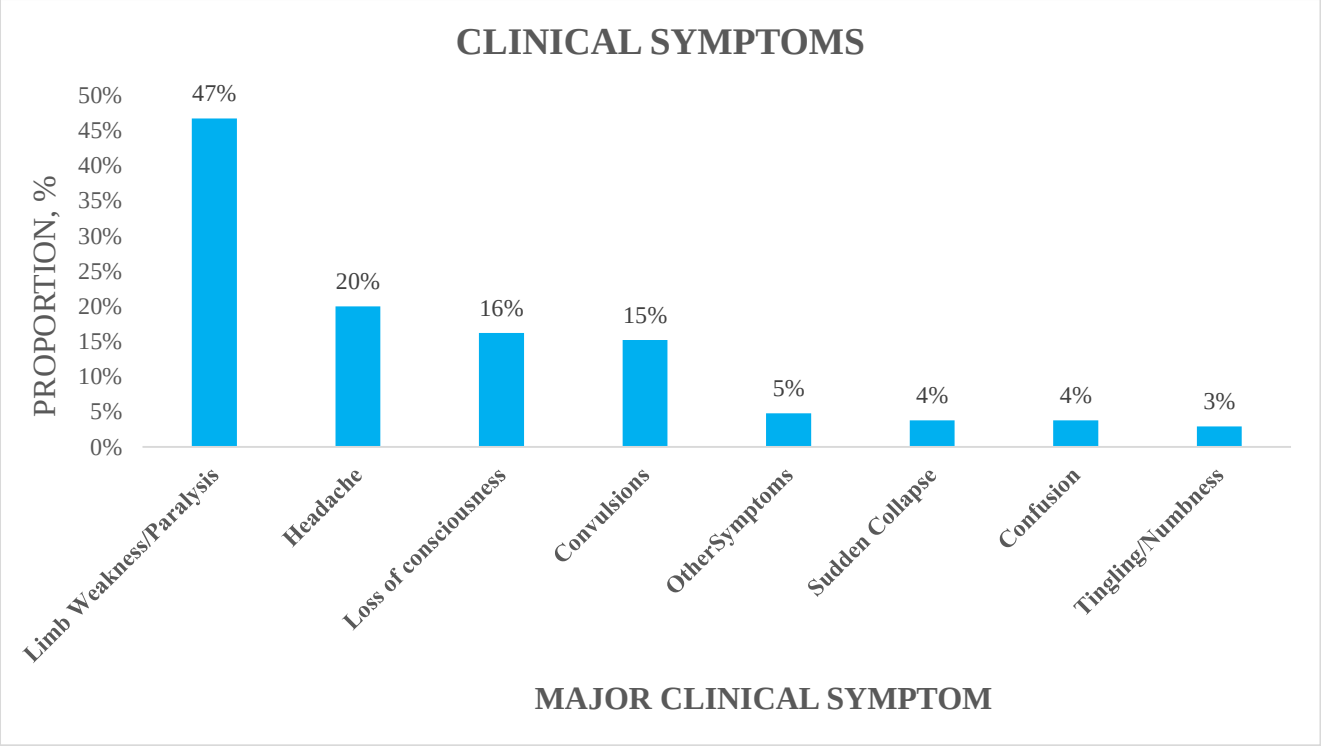


Figure 5: Bar graph showing the major symptoms leading to a clinical suspicion of stroke.

Imaging findings

Initial NECT cranial scans revealed 45 strokes cases, accounting for 42.4% of the findings. Stroke mimics (including clinically insignificant findings) accounted for 18% of the imaging findings. There were 42 (39.6%) normal studies (table 2 and figure 6 below).

Table 2: Table showing the major imaging findings.

Main findings	**Frequency, *N***	**%**
Normal	42	39.6
Cerebral infarction	25	23.6
Haemorrhagic stroke	17	16.0
Other findings (stroke mimics)	19	18
Sub-arachnoid haemorrhage (SAH)	3	2.8
Total	**106**	**100**

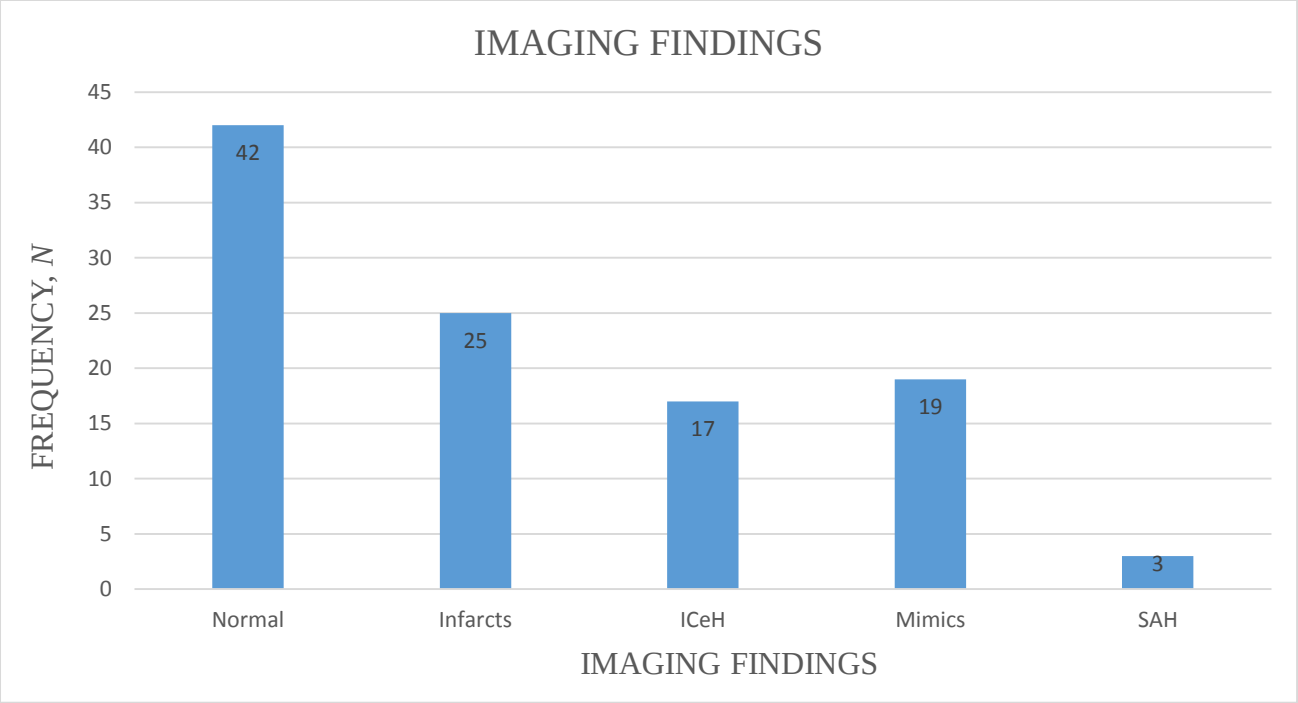


Figure 6: Graph illustrating the main findings.

Age distribution of imaging findings

Ischemic strokes were commonest in the 60-79 years age group while hemorrhagic strokes were equally seen in the 40- 59 and 60- 79 age groups. Patients aged 20-39 years accounted for the majority of stroke mimics and normal CT scans (figure below7).

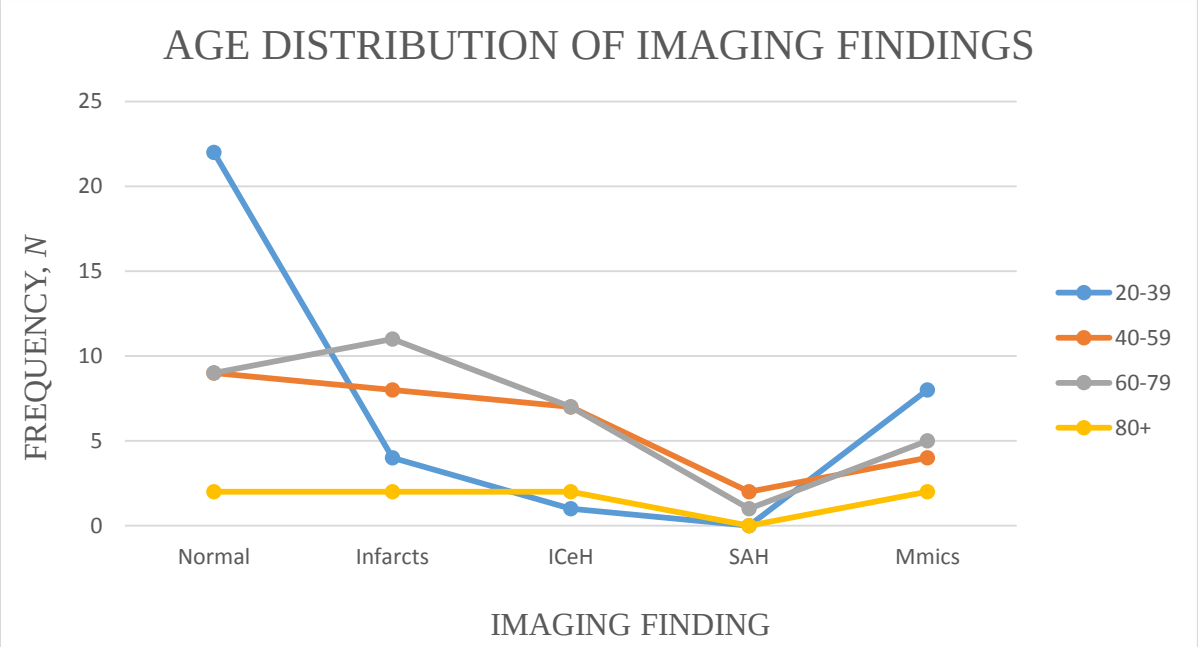


Figure 7: Graph showing the frequency of imaging findings across the age groups.

Stroke subtypes

There were 45 cases of stroke, the commonest pathologic subtype being cerebral infarction (55.6%). Haemorrhagic strokes and acute sub-arachnoid haemorrhages represented 37.8% and 6.6% of the stroke subtypes respectively (table 3 and figure 8 below).

Table 3: Table showing the pathologic subtypes of stroke.

Stroke subtype	**Frequency, N**	**%**
Cerebral infarction	25	55.6
Intracerebral haemorrhage	17	37.8
Acute sub-arachnoid haemorrhage	3	6.6
Total	**45**	**100**

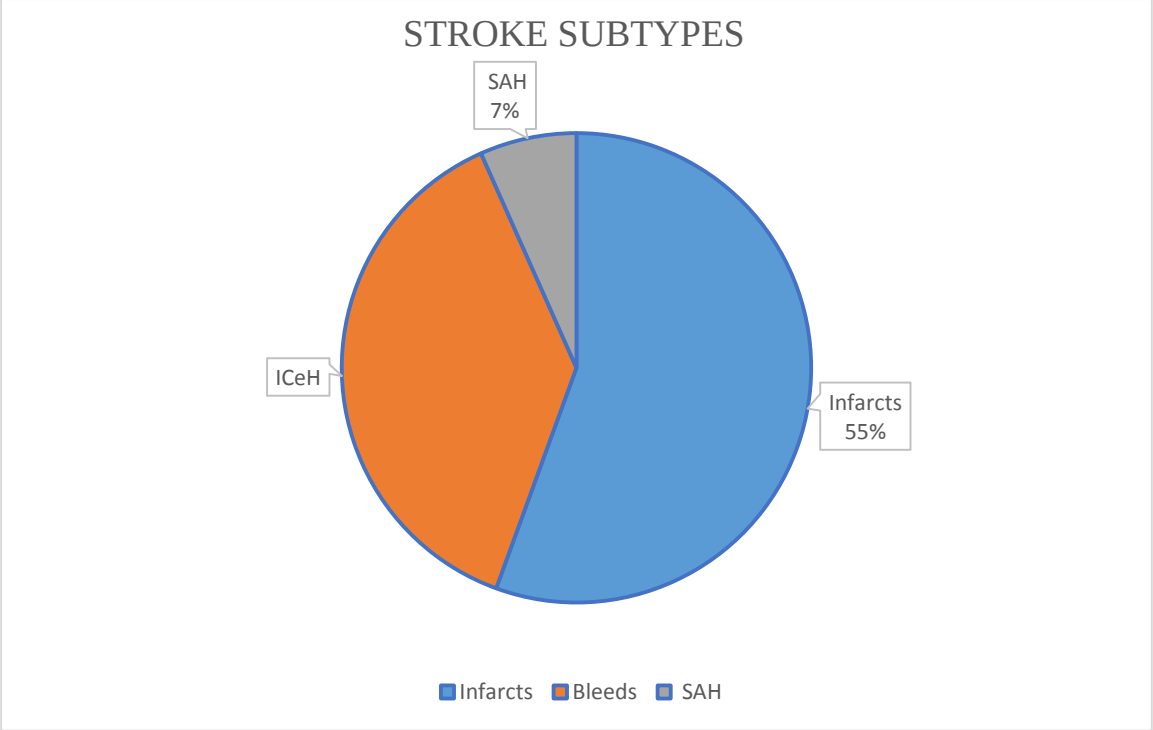


Figure 8: Pie chart depicting the proportions of the stroke subtypes.

Ischemic stroke

Anatomic distribution of infarcts

All the infarcts involved the MCA territory: 72% of the infarcts were purely cortical, 16% involved the basal ganglia while the remainder involved both the cortex and the ganglionic region. Left-sided infarcts accounted for 60%, while there was only a single case of bilateral (cortical) infarction. See selected cases in the section of illustrations (figures 11- 13).

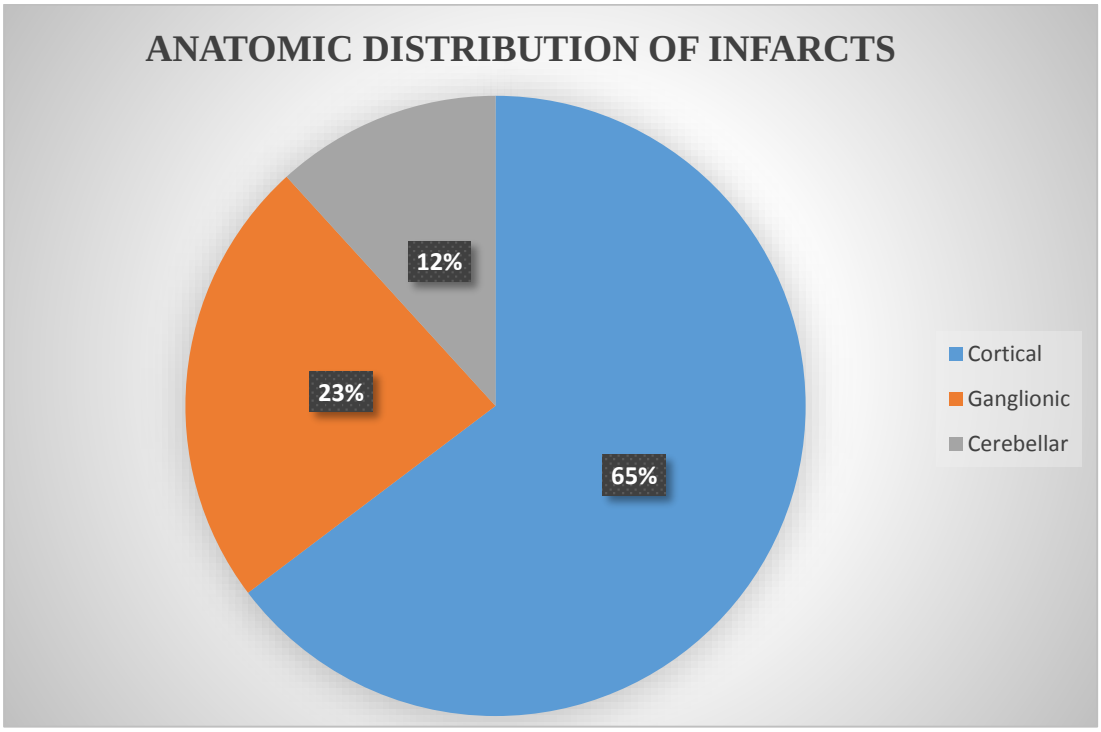


Figure 9: Pie chart showing the anatomic distribution of ischemic strokes.

Infarct size

Using the ASPECTS scoring system for infarct size, 14 patients (63.7%) had ASPECTS scores of 7 and above, thus were eligible for thrombolysis if they met the time criteria. There was a single case of complete MCA territory infarct, a score of 0/10 (table 4).

Table 4: Table showing the sizes of infarcts as per the Alberta Stroke Program Early CT Score (ASPECTS). Higher scores mean smaller infarct volume, and vice-versa.

ASPECTS Score (/10)	Frequency (N)	%
0	1	4.5
3	1	4.5
4	3	13.6
5	2	9.1
6	1	4.5
7	6	27.3
8	6	27.3
9	2	9.1

Haemorrhagic stroke

Acute intracerebral bleeds were found in 17 patients, representing 35.4% of the stroke subtypes. Supratentorial bleeds accounted for 88.2%, with an almost equal lateralization (left 8, right 7). There were 4 striato-basal haemorrhages, a 23.5% proportion of all the intracranial hematomas. Three of the supratentorial bleeds showed intraventricular extension. There were only 2 cerebellar and pontine haemorrhages (figures 10, 14 and 15).

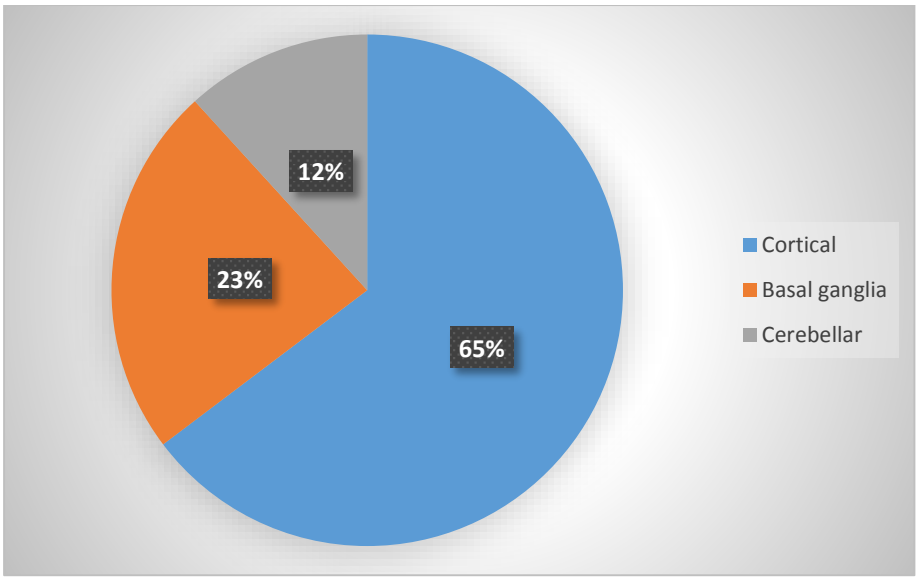


Figure 10: Pie chart showing the anatomic distribution of haemorrhagic stroke.

Stroke mimics

A total of 19 (18% of all the CT scans) revealed findings other than stroke, 73.7% of which were of clinical significance. For instance, subdural hematomas unrelated to trauma were seen in 3 patients. The subsequent clinical management of this subgroup of patients was appropriately premised on the imaging diagnosis. A minority of the findings (26.3%) were of no clinical significance (table 5). A single exception was bilateral speckled calcification of the globi pallidi and dense pineal gland calcification consistent with a diagnosis of Fahr syndrome(32)(33). See figure 19 in the illustrative cases section.

Table 5: Table showing non-stroke intracranial findings (stroke mimics) on CT.

Finding	N	%
Intracranial mass	4	21
Diffuse cerebral oedema	4	21
Senile cerebral atrophy	4	21
Subdural haemorrhage	3	15.9
Intracerebral abscess	2	10.5
Leptomeningitis	1	5.3
Fahr syndrome	1	5.3
Total	**19**	**100**

Average time to imaging

Patients with stroke symptoms presented for imaging more than 3.5 hours after symptom onset ($p < 0.001$).The overall average time to imaging was 70.8 hours (SD, 24.8 hours); range 9-84 hours. The majority of patients (74.5%) presented for imaging 2-5 days after onset of symptoms. Patients with infarcts presented for imaging marginally earlier, mean 67.2 hours (table 6, next page).

Table 6: Table showing the average time from the onset of stroke symptoms to initial imaging.

Time	Findings				
	Normal	Infarcts	Bleeds	SAH	Others
0-3 hours	-	-	-	-	-
3-6 hours	-	-	-	-	-
6-12 hours	2	2	-	1	-
12-48 hours	7	5	5	0	2
2-5 days	33	18	12	2	17
Total	42	25	17	3	19

Treatment and outcome of ischemic stroke

All the patients with infarcts were admitted and received antiplatelets (clopidogrel or aspirin). There was no administration of a thrombolytic drug. Other treatment included the correction of underlying diseases such as hypertension and/ or diabetes. The 60-day ischemic stroke outcomes were mortality (8%), residual limb weakness (48%), recurring convulsions (16%) and symptomatic improvement (8%). Five patients were lost to follow up.

Table 7: Table showing the 60-day outcomes of ischemic stroke.

Outcome	**Frequency, N**	**%**
Residual weakness/ paralysis	12	48
Recurring convulsions	4	16
Symptomatic improvement	2	8
Death	2	8
Lost to follow up	5	20
Total	**25**	**100**

ILLUSTRATIVE CASES

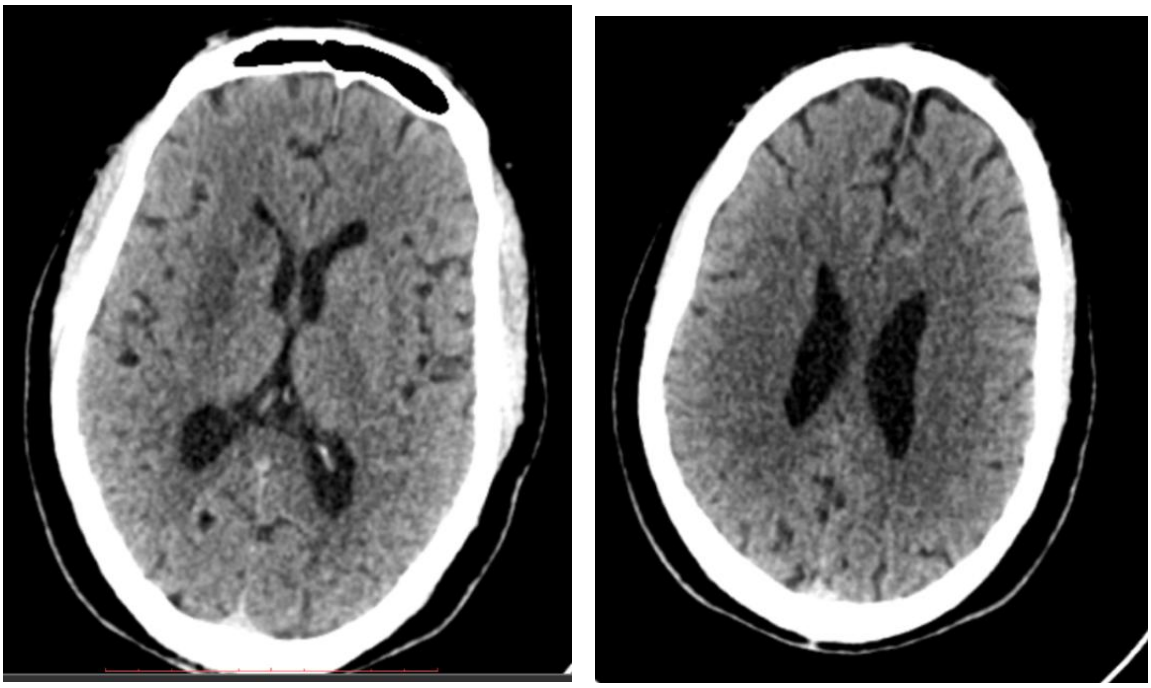


Figure 11: Axial non-enhanced CT brain of a 45 year old male showing acute infarct of the right lentiform and caudate. Estimated time to imaging was 30 hours.

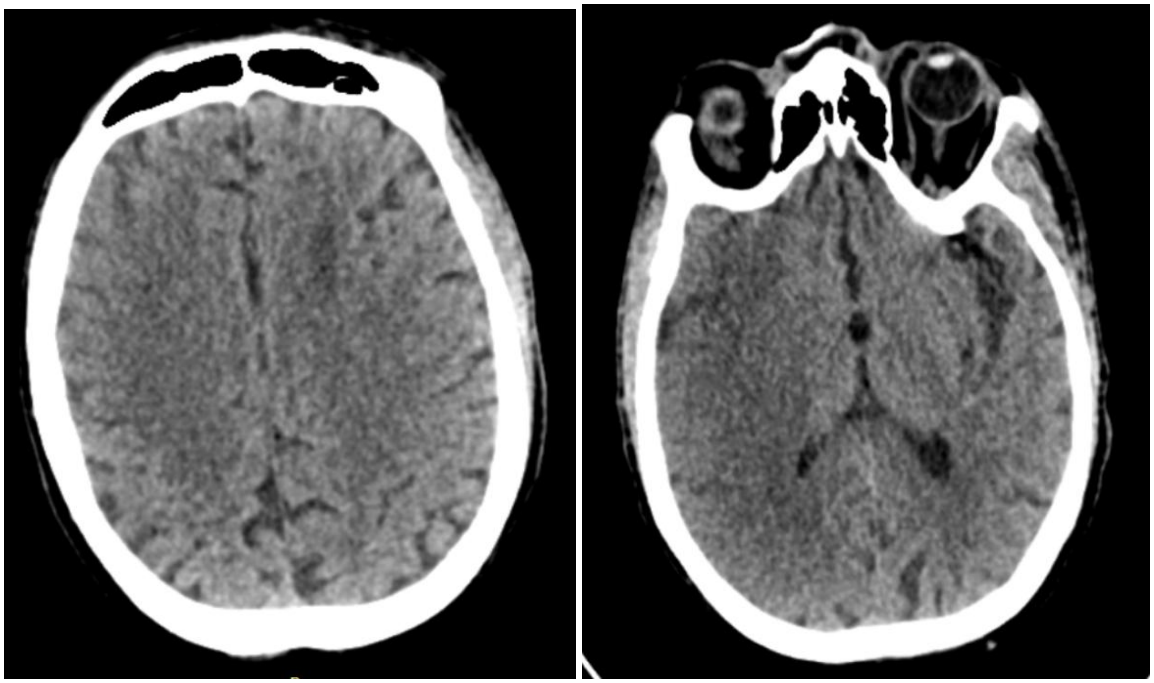


Figure 12: Selected axial NECT brain of a 76 year old male show acute infarction of the right insular cortex and lentiform nucleus. Patient presented about 40 hours after sudden onset left hemiparesis.

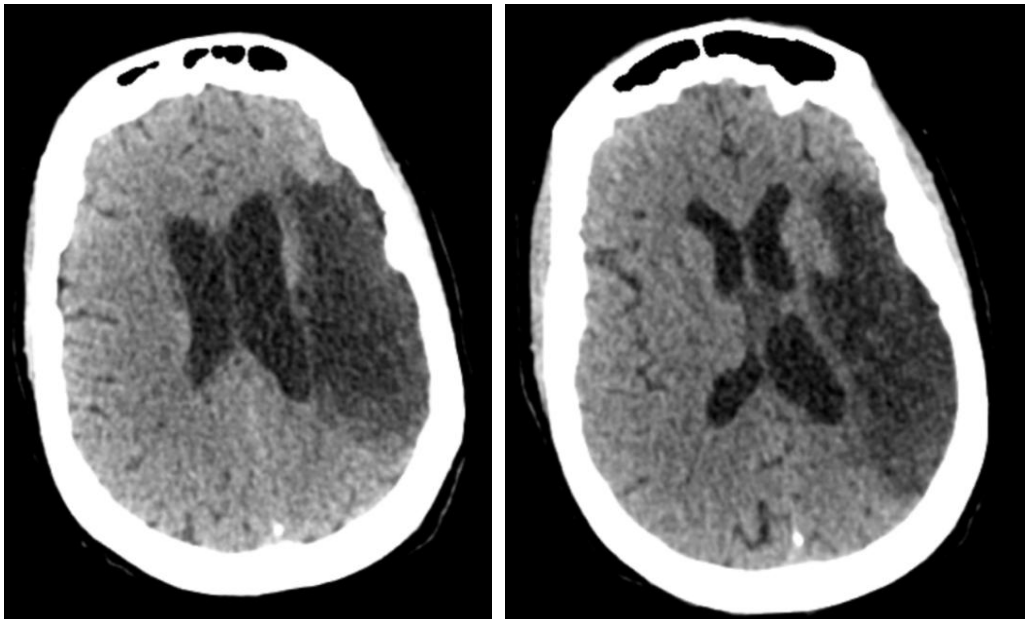
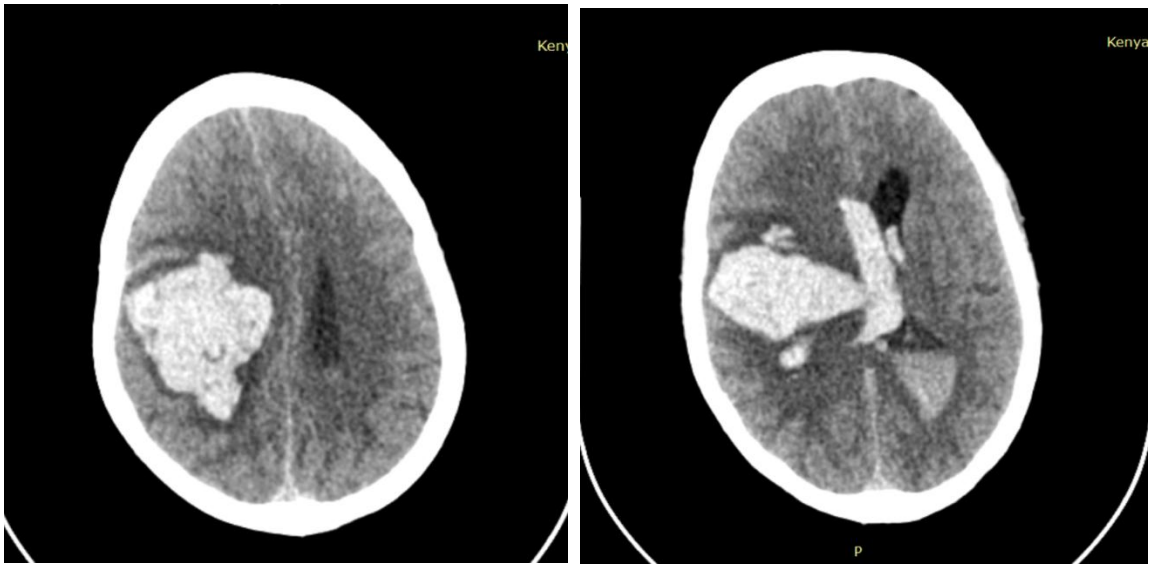
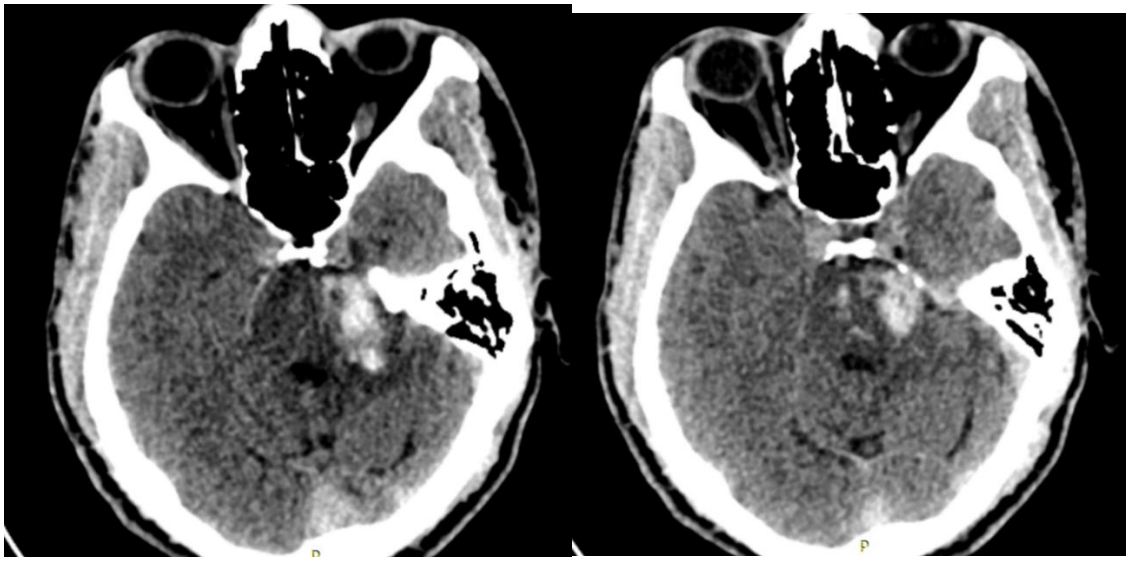


Figure 13: Axial NECT brain showing established left MCA territory infarct in a 67 year old female with chronic hypertension. Patient had presented with convulsions and right sided weakness over 5 days.



(a) (b)

Figure 14: Axial NECT brain showing acute right parietal intracerebral haemorrhage with mass effect in a 40 year old female who presented with left hemiplegia after 24 hours. There is bilateral intraventricular haemorrhage with a blood-CSF level in the left lateral ventricle (figure b).



(a) (b)

Figure 15: Axial NECT brain of a 40-year old hypertensive male. Acute haemorrhage in the left middle cerebellar peduncle and the pons is seen. The patient presented for imaging after 48 hours of sudden onset of limb weakness and incoordination.

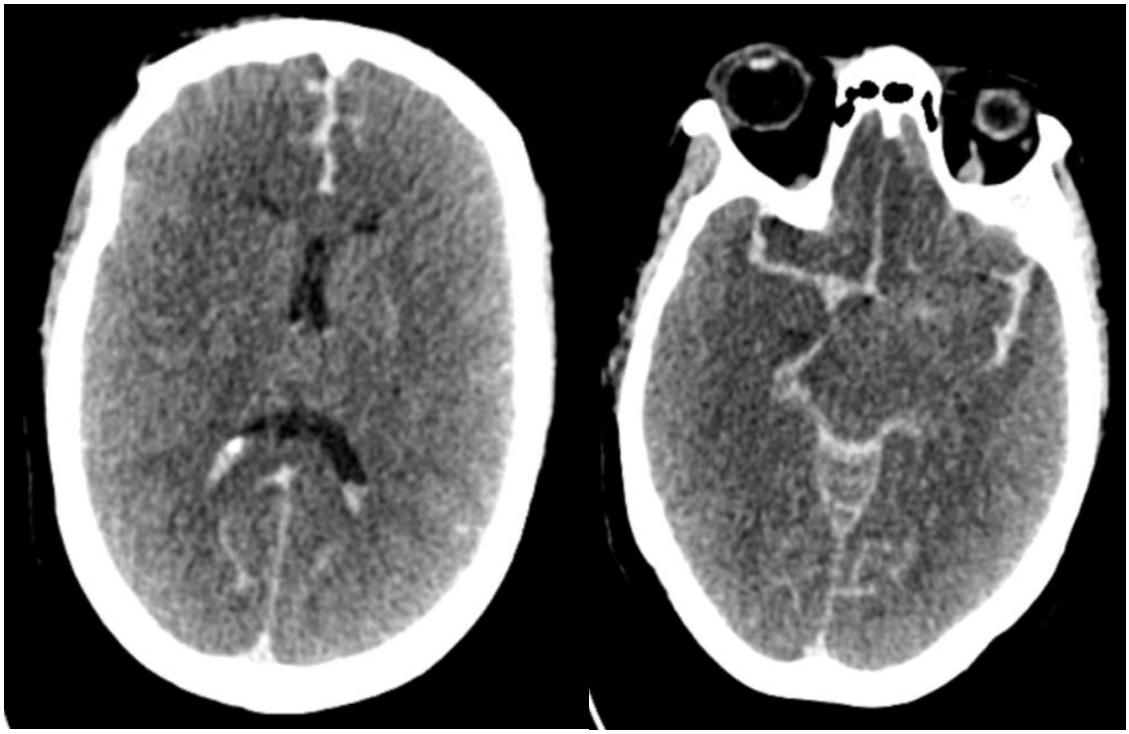
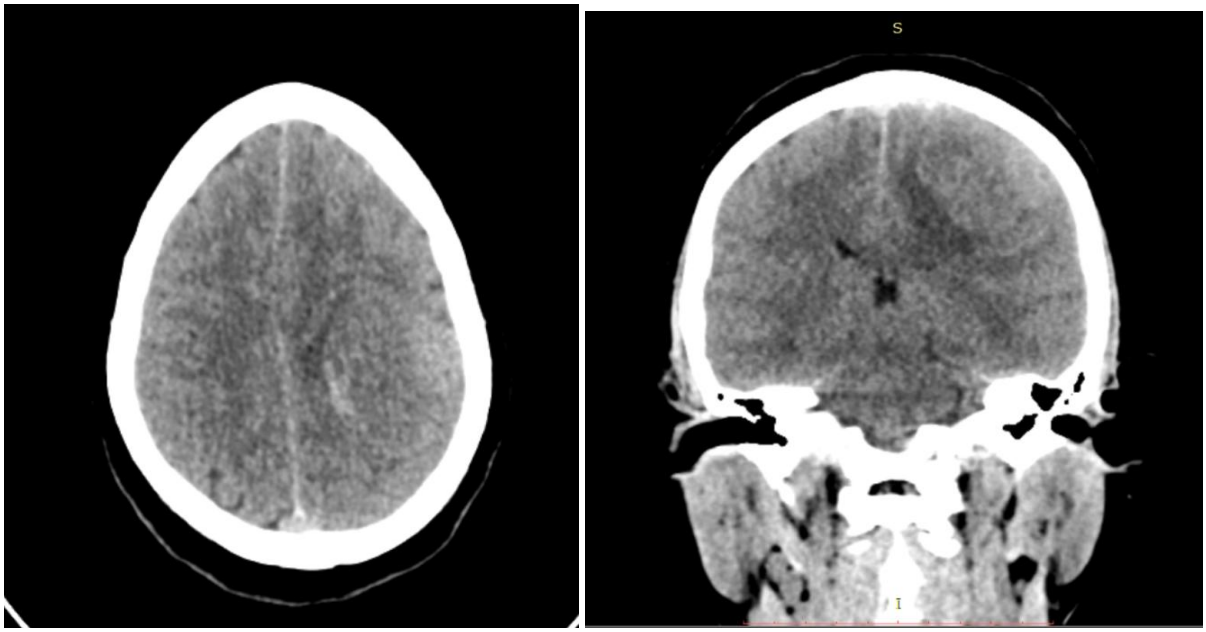


Figure 16: Axial NECT brain showing acute sub-arachnoid haemorrhage in a 56 year old female reported to be aphasic for 12 hours. There is hyperdense blood within the basal and convexal sub-arachnoid spaces.



(a) (b)

Figure 17: Axial (a) and coronal (b) NECT brain of a 31 year old female showing a hyperdense left fronto-parietal intra-axial mass confirmed to be a glioblastoma. The patient had presented with acutely worsening right-sided weakness.

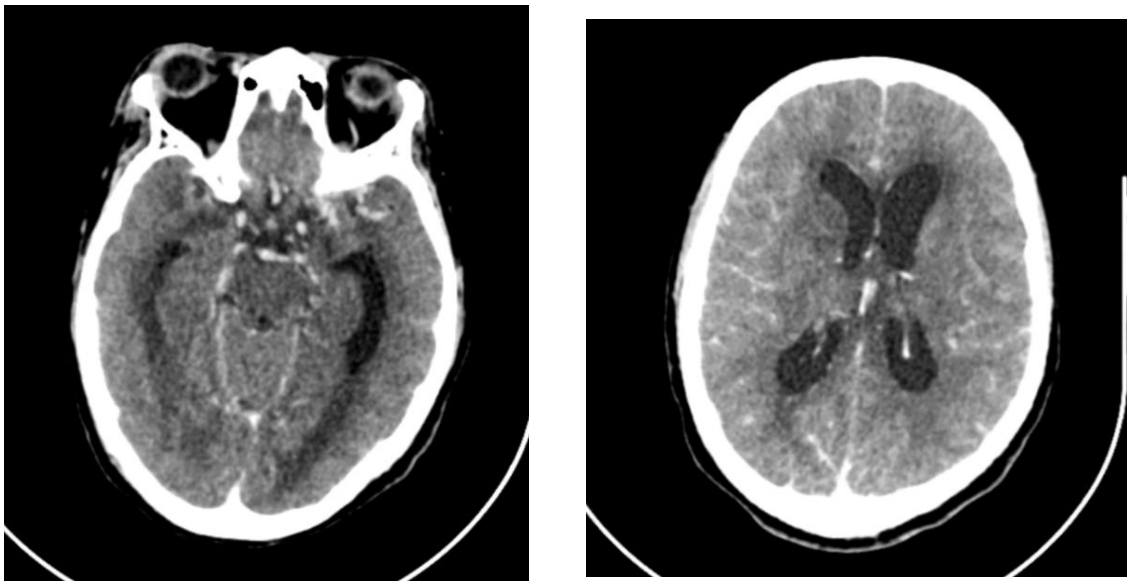


Figure 18: Post-contrast axial brain CT scans of a 30 year old male with limb weakness and headaches. Diffuse leptomeningeal enhancement is seen. The CT scan was acquired 4 days after the onset of symptoms.

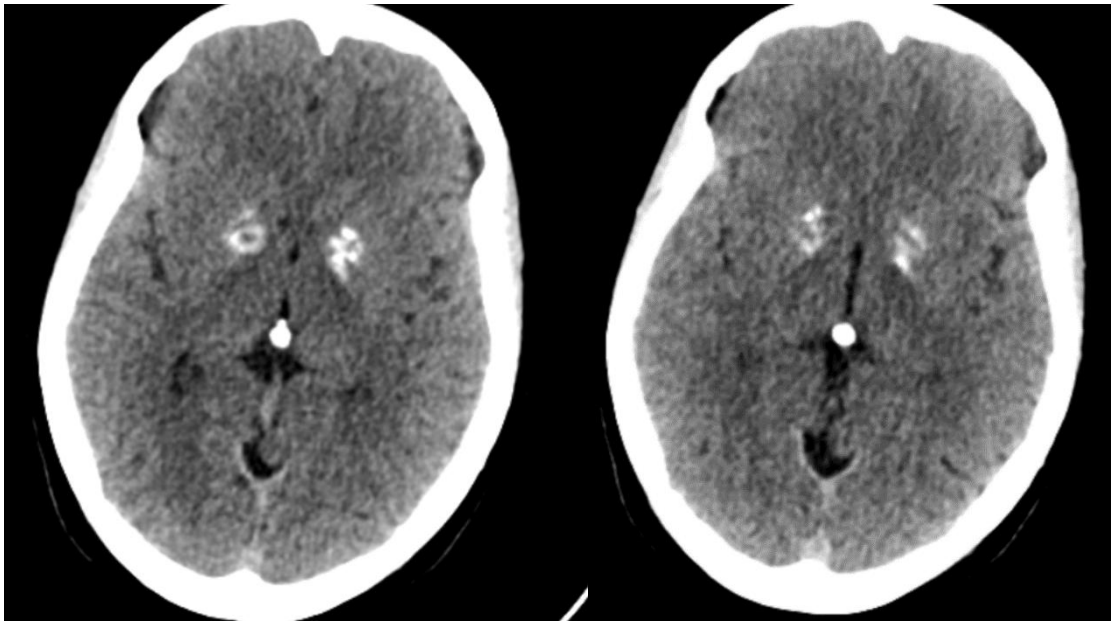


Figure 19: Axial non-contiguous NECT brain of a 39 year old female showing bilateral dense speckled calcification of the globi pallidi, in keeping with Fahr disease. The patient was a known hypertensive who presented with acutely worsening headache for about 48 hours before imaging.

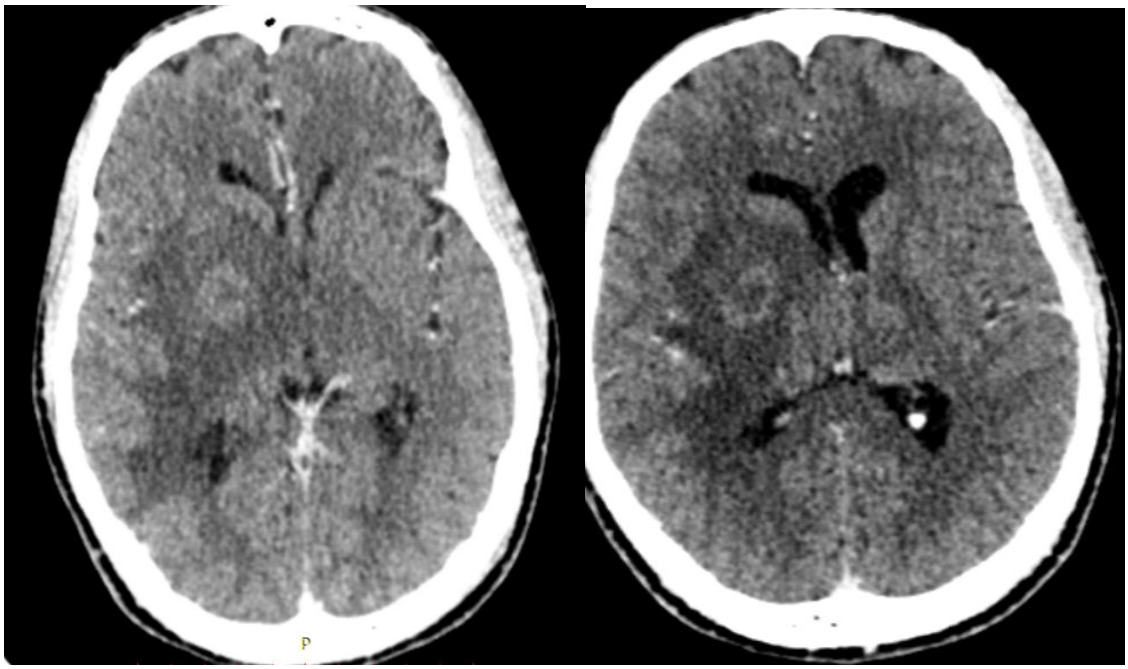


Figure 20: Selected axial contrast enhanced CT brain of a 33 year old male demonstrating a rim enhancing abscess centred in the right basal ganglia. There is marked perilesional oedema and mass effect. The patient presented with left hemiplegia and convulsions. CT scan was acquired 72 hours after symptom onset.

CHAPTER FIVE

DISCUSSION

To our knowledge, this is the first local study that has examined the pattern of cranial CT findings in patients presenting with stroke symptoms alongside the time delays from symptom onset to initial imaging, as well as the short-term outcomes of the potentially treatable ischemic strokes.

The finding that ischemic strokes are the commonest pathological stroke subtype concurs with the findings by Jowi et al at Nairobi Hospital, an urban private hospital. However, there are marked differences in the actual proportions reported. For instance, ischemic strokes accounted for 85% compared to 55.6% in this study. Similarly, Thiringi et al found a higher incidence of ischemic strokes (68.1%) in a study based in two other private hospitals in Nairobi. This could be a pointer to differing patient risk factor profiles in the private and public hospitals. Undocumented evidence shows that patients seen at private hospitals have a higher burden of diabetes and dyslipidemias, which could potentially lead to higher incidences of thrombotic cerebral infarcts.

This study demonstrates the predominance of anterior territory infarcts. Notably, no ACA, PCA or vertebrobasilar infarcts were seen. Larger studies utilizing different methodologies have shown a similar distribution. However, differences exist in the proportion of posterior circulation strokes found with other imaging modalities like MR. Utilizing DWI in an etiological study of ischemic stroke, Chung et al found a higher proportion of vertebral and PCA infarcts at 11.3% and 8.5% respectively. Diffusion-weighted MRI has been shown to be sensitive to small vessel infarcts which more frequently affect the vertebrobasilar circulation and may be occult on CT.

Primary intracerebral haemorrhages accounted for 37.8% of strokes in our patients. This is considerably higher than in other studies reporting a maximum of 20%. For instance, the Italian Aosta stroke registry recorded 11% in a pool of 1326 patients. Methodological, and perhaps patient risk factor differences, could account for this.

Although a statistically significant difference in time to presentation between ischemic and haemorrhagic strokes was not found in our study, the clinical presentation of haemorrhagic stroke is known to be more sudden compared to the gradually evolving ischemic strokes. The neurological status after intracerebral haemorrhage is also often poorer leading to priority referral to tertiary centres, and therefore the higher numbers of haemorrhagic strokes.

Stroke mimics are important clinical differential diagnoses of stroke, and have been observed to contribute up to 30% of the imaging findings in some studies. We recorded a comparatively lower incidence of 18%. In an analysis of acute stroke mimickers in 8187 patients referred to the NIH stroke service in the USA, female gender, younger age and the absence of risk factors such as hypertension were noted to be important predictors of the finding of stroke mimics- or even normal studies- at imaging. In our study, patients aged 20-39 years contributed to the most normal studies and stroke mimics. Our study relied on clinician suspicion of stroke. The referring clinicians mostly consisted of general medical practitioners and internists. No systematic risk stratification for stroke was carried out and this could partly explain the inclusion of relatively young patients who accounted for the majority of normal findings, and potentially leading to less accurate estimation of stroke proportions.

The recorded long time delays between onset of stroke symptoms and imaging compare closely to observations in other African studies similarly based in large referral hospitals. In a Nigerian study, none of the 83 stroke patients presented to hospital within 3 hours. The mean time of presentation was long, averaging 70 hr. This could be partly explained by complex long referrals and lower stroke literacy levels in the populations. The lack of specialised acute stroke care units and awareness means patients experiencing stroke symptoms are subjected to the general outpatient and referral system.

Contrasting observations were made in the Aosta study in Northern Italy, where, with active patient surveillance, the median time to presentation was markedly shorter at 5.4 hours. In spite of this, other barriers to seeking early stroke care have been identified even in the developed countries where stroke literacy levels are conceivably higher. In a black urban population in Washington, USA, only 12% of stroke patients called 911. In this community, healthy volunteers reported an 89% likelihood to call 911 in the event of a stroke(34).

None of the patients in our study received thrombolytic drugs nor underwent mechanical thrombectomy. Evidence from multiple trials consistently shows improved outcomes of thrombolysis in acute ischemic stroke within 3 hours. In a multi-trial pooled analysis, Kennedy R. Lees et al demonstrated improved outcomes with treatment delays up to 4.5 hours, although greater benefits were conferred within 3 hours using r-tPA. No published local experience with the use r-tPA for initial stroke thrombolysis was found.

International trials have demonstrated safety, efficacy and improved patient functional outcomes using mechanical thrombectomy. For instance, a meta- analysis of data from various trials utilizing the Solitaire™ device showed a revascularization success rate of 77%. Mechanical thrombectomy alone, or in combination with intra-arterial r-tPA was found to be safe for up to 6 hours post-ictus therefore extending the therapeutic window for stroke intervention.

The poor 60-day neurological outcomes and mortality in ischemic stroke patients can be attributed to the lack of active treatment to salvage the at-risk brain, specifically using thrombolytic drugs and mechanical thrombectomy. Based on the criterion for infarct size (ASPECTS $\geq$ 7), 63.7% of our patients would qualify for thrombolysis. However, this benefit is negated by the exceedingly long prehospital delays recorded. We believe the recorded poor outcomes can be mitigated by early patient presentation, achieved through concerted public education efforts, stroke interventions and thrombolysis.

Conclusion

Ischemic stroke was the commonest stroke subtype, followed by primary intracerebral hemorrhages. There was however a greater percentage of stroke mimics which included intracranial space-occupying lesions, intracerebral abscesses and meningitis.

The mean time from onset of symptoms to imaging was long (70.8 hours), with no patient with ischemic stroke being eligible for thrombolytic therapy. Associated poor short-term neurologic outcomes at 60 days were recorded in the ischemic stroke subgroup.

Study limitations

The study methodology relied on clinician suspicion of stroke. The referring clinicians consisted mostly of general medical practitioners and internists. No systematic risk stratification for stroke was carried out, and this could partly explain the inclusion of relatively young patients who accounted for the majority of normal findings, and potentially leading to less accurate estimation of stroke proportions.

The lack of an integrated electronic record keeping made it difficult to consistently trace all the patient records among the departments. When appropriate, we made contact with the patients' next of kin via phone calls in case patients were transferred or discharged. Some stroke patients had significant limitations of speech and mobility. Engaging them in verbal interviews was difficult. Consenting caretakers were requested to provide the history to the best of their recall.

Recommendations

Public education on stroke, focusing on symptom awareness and the need to present early for treatment should be carried out. At the hospital, a stroke desk and dedicated team at the outpatient emergency department should be set up to help with more rapid triaging, referral for imaging and admission of stroke patients for possible thrombolysis. Structured clinical patient risk stratification should be adopted by the referring clinicians as we noted that stroke was an unlikely diagnosis in patients below 40 years age. There should be efforts to avail safe options for rapid thrombolysis of eligible patients either with IV thrombolytics, mechanical thrombectomy or a combination as per the clinical outlook.

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APPENDICES

Appendix 1: Time plan

	FEBRUARY 2017-MAY 2017	JUNE 2017-JULY 2017	SEPTEMBER 2017	OCTOBER 2017	NOVEMBER, 2017- APRIL, 2018	APRIL 2018	APRIL-MAY 2018	MAY, 2018
PROPOSAL WRITE UP	X							
CORRECTION OF SUPERVISORS INPUT	X							
1ST SUBMISSION TO KNH-UON-ERC		X						
CORRECTIONS AND RESUBMISSION			X					
FINAL SUBMISSION AND EXPECTED APPROVAL				X				
DATA COLLECTION					X			
DATA ENTRY						X		
DATA ANALYSIS							X	
REPORT WRITING							X	
DISSERTATION SUBMISSION								X

Appendix 2: Budget

ITEM	UNIT COST	NUMBER	TOTAL COST
RESEARCH ASSISTANTS/DATA COLLECTION CLERKS	5000.00	8	40000.00
BIOSTATISTICIAN FEES	30000.00		30000.00
SUPPLIES AND EQUIPMENT			
PRINTING RESEARCH PROPOSAL	5.00	6 (EACH WITH 40 PAGES)	1200.00
PRINTING CONSENT AND DATA COLLECTION FORMS	5.00	200(EACH WITH 8 PAGES)	8000.00
PENS	20.00	20	400.00
AIRTIME	1000.00		1000.00
INTERNET COST	5000.00		5000.00
PRINTING REPORT	5.00	10 COPIES(EACH WITH 80 PAGES)	4000.00
MISCELLANEOUS			4000.00
CONTINGENCY(10% OF THE BUDGET)			9360.00
GRAND TOTAL			**105660.00**

Appendix 3: Consent for participation in the study

This consent has three parts:

1. Participant information sheet
2. The consent form
3. Statement by the researcher.

Participant information sheet

Investigator's statement

My name is Dr David Ochieng Omondi, a postgraduate student at the University of Nairobi, Department of Diagnostic Imaging and Radiation Medicine. I am conducting a study on the "**Spectrum of Imaging Findings in Stroke, and the Average Time to Neuroimaging at Kenyatta National Hospital."**

I am requesting you to take part in the study. The purpose of this consent form is to help you decide whether you want to be included in the study or not. Please read through the form carefully. You are free to ask any questions about the study. The investigator will be available to answer any questions during the study or thereafter.

Brief description of the study

Stroke is a leading cause of morbidity and mortality in Kenya. The short term and long term effects on the quality of life as the well as the financial costs of stroke are immense. Significant strides have been made to improve the rapid diagnosis and management of stroke.

However, late presentation to hospital has been identified as a major negative contributor to the outcomes of treatment. Presenting to hospital more than 3 hours after the onset of symptoms is a contraindication to the administration of potentially lifesaving drugs known as thrombolytics.

Benefits

This study, if completed, will directly contribute to a better understanding of the patterns of stroke encountered locally. It would shed light on the average time patients experiencing stroke symptoms take to present for care, and contribute to improving stroke literacy levels. Addressing identified gaps would lead to better treatment outcomes of stroke.

Duration of study

6 months.

Compensation

You will receive no compensation for participating in the study.

You have the right to refuse or withdraw from the study.

You are free to choose whether or not to participate in the study. You will suffer neither penalties nor loss of any benefits for declining to participate in the study.

Confidentiality

If you agree to participate in the study, information from your examination will be kept strictly confidential and will only be used for the purpose of this study. Information obtained will be kept under lock and key and soft copy information will be password protected. No specific information of any participant will be revealed to any person without their permission in writing. Your names will not appear on any of the records used for this study.

Risks

This study involves use of ionizing radiation, and possibly, iodinated contrast media. Established protocols will be used to limit the radiation dose to the patient. Measures will be taken to minimize adverse effects from iodinated contrast media.

Minor adverse reactions to iodinated contrast media including: nausea, sneezing, cough, flushing.

This occur in a small proportion of patients and if any reactions occur they will be addressed immediately.

The Consent form

I hereby confirm that the investigator has explained to me about the above study and I understand it fully. I have been given the opportunity to ask questions regarding the study which have been adequately answered.

I understand that my participation is voluntary and that I have not been forced to participate. I understand that I can decline without giving any reason; and medical care and my legal rights will not be affected.

I understand that I will not receive any compensation either financial or otherwise and will not receive any preferential treatment, gift or reward for participating in the above study.

I understand that my personal information will be kept confidential but any relevant medical information will be accessible to the researcher and the supervisors where relevant to the study.

I give them permission to have access to this information, and hereby consent to take part in the above study.

Respondents signature ……

Respondents code …… Date ……

Researcher's statement

I hereby confirm that I have accurately read out the contents of the information sheet to the participant.

To the best of my ability, I have made sure the participant understands the following:

1. Participation in this study is on voluntary basis and no compensation will be given.
2. Refusal to participate or withdraw from the study at any point will not in any way compromise the quality of care accorded to the patient.
3. All the information that shall be given will be treated with confidentiality.

Name …….

Signature …….. Date ……

Who to contact:

If you have any queries regarding the study or your participation in the study you can contact the Principal Investigator:

DR DAVID OCHIENG OMONDI,

Department of Diagnostic Imaging and Radiation Medicine,

University of Nairobi,

P.O Box 15167-00100,

NAIROBI.

Mobile: +254724339928 Email to: dromondi@live.com

If you have any questions on your rights as a research participant you can contact Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee whose task is to ensure research participants are protected from harm.

KENYATTA NATIONAL HOSPITAL/UNIVERSITY OF NAIROBI ETHICS AND RESEARCH REVIEW COMMITTEE (KNH-UoN ERC):

1. **Contact Person:**

Esther Wanjiru Mbuba

E-mail: uonknherc@uonbi.ac.ke

2. **University of Nairobi**

College of Health Sciences

P.O Box 19676-00202

Tel. +254202726300 Ext 44355

3. **Kenyatta National Hospital,**

P.O Box 20723-00202

Tel. +25420 726300 Ext 44102, 44355

Fax: 725272

Kibali cha kushiriki katika utafiti

Kauli ya mtafiti

Jina langu ni Dr David Ochieng Omondi, mwanafunzi wa uzamili katika Chuo Kikuu cha Nairobi, Idara ya Radiologia na Dawa Mionzi. Utafiti huu unahusu matokeo ya uchunguzi wa wagonjwa wanaokisiwa kuwa na *stroke*katika Hospitali kuu ya Kenyatta.

Ningependa kuomba ushiriki katika utafiti huu.

Madhumuni ya fomu hii ya idhini ni kukusaidia kuamua kama ungekubali kushiriki katika utafiti au la. Tafadhali soma fomu hii kwa makini. Uko huru kuuliza maswali yoyote kuhusu utafiti huu. Mtafiti au wasaidizi wake wataweza kujibu maswali yoyote wakati wa utafiti au baada ya kukamilika kwa utafiti.

Maelezo mafupi kuhusu utafiti

Utafiti huu una nia yakufafanua matokeo yanayopatikana katika uchunguzi wa wagonjwa wanaokisiwa kuwa na shida ya *stroke*. Pia utachunguza ule muda unaochukuliwa na wale wagonjwa kabla kufika hospitali kwa chunguzi hizi na matibabu. Pia, tutatafiti kiwango cha wagonjwa wanaopokea dawa zijulikanazo kama *thrombolytics*.

Faida

Matokeo ya utafiti huu yatawekwa waazi kwa faida ya madaktari na wafanyikazi kwenye hospitali ili kuelezea kwa kina baadhi ya matokeo yapatikanayo kwenye wagonjwa wanaochunguzwa kwa kukisiwa kuwa na *stroke*. Manufaa kwa taifa nzima yatapatikana iwapo kiwango cha matibabu ya *stroke* kitaimarika.

Muda wa utafiti: Miezi sita (6).

Fidia: Hakuna fidia yoyote kutokana na kushiriki katika utafiti.

Haki ya kukataa au kujiondoa katika utafiti

Uko na uhuru wa kuchagua kushiriki katika utafiti huu. Hautaadhibiwa au kunyimwa huduma unayohitaji kwa kutoshiriki katika utafiti huu.

Siri ya utafiti

Taarifa zote na matokeo ya utafiti huu zitalindwa vilivyo na kuwekwa katika hali ya siri. Hakuna taarifa maalum ya mshiriki yeyote utafafanuliwa kwa mtu yeyote bila idhini yako kwa maandishi. Majina yako hayataonekana kwenye kumbukumbu zautafiti huu.

Appendix 4: Data collection sheet.

BIODATA

DATE OF BIRTH……..

AGE (YEARS) ……...

GENDER: M / F

XRAY NUMBER……

DATE OF IMAGING (DD/MM/YY) ……/……/……

TELEPHONE NUMBER……

Clinical symptoms

Limb weakness/ paralysis

Sudden collapse

Loss of consciousness

Loss of vision/ blurred vision

Tingling/ numbness

Other: specify

……

……

……

Time of onset before imaging

0-3 hr

3-6 hr

6-12 hr

12-48 hr

2-5 days

Initial imaging requested

CT

CTA

MRI

FINDINGS:

Main findings

Normal

Infarction/ ischaemia

Intraparenchymal haemorrhage

Subarachnoid haemorrhage

Side: L/R Bilateral

Site:

Basal ganglia

Cortical

Frontal

Parietal

ASPECTS SCORE (/10)

Occipital

Cerebellar

Brainstem

Intraventricular bleed

Cerebral deep venous thrombosis

Cortical venous thrombosis. Specify cortical vein:

Dural sinus thrombosis

Intracranial mass

Ancillary findings:

Brain oedema

Mass effect

Herniation. Specify:

……..

……..

……...

Other imaging findings. List:

……...

……...

……

Drugs prescribed

1. Thrombolytic (e.g. alteplase)

   State dose and frequency…….

2. Antiplatelets (e.g. aspirin, clopidogrel)

3. Others. Specify:

60-day outcome clinical review

Functional status: Dependent …… Independent …….

Residual symptoms

Resolved symptoms

Death

Lost to follow up

Appendix 5: The Alberta Stroke Program Early CT Score (ASPECTS)

This is a 10- point quantitative topographic CT scan score which is systematic and practical with superior inter-observer agreements(35). It involves segmental assessment of the middle cerebral artery (MCA) territories:

1. Caudate
2. Putamen
3. Internal capsule
4. Insular cortex
5. M1: anterior MCA cortex, corresponding to the frontal operculum
6. M2: MCA cortex lateral to insular ribbon corresponding to the anterior temporal lobe
7. M3: posterior MCA cortex corresponding to the posterior temporal lobe
8. M4: anterior MCA territory immediately superior to M1
9. M5: lateral MCA territory immediately superior to M2
10. M6: posterior MCA territory immediately superior to M3

Methodology

Two non-enhanced (NECT) axial slices are examined at the level of the basal ganglia and internal capsule, and at the bodies of the lateral ventricles

Ten (10) regions are identified: four deep and six cortical

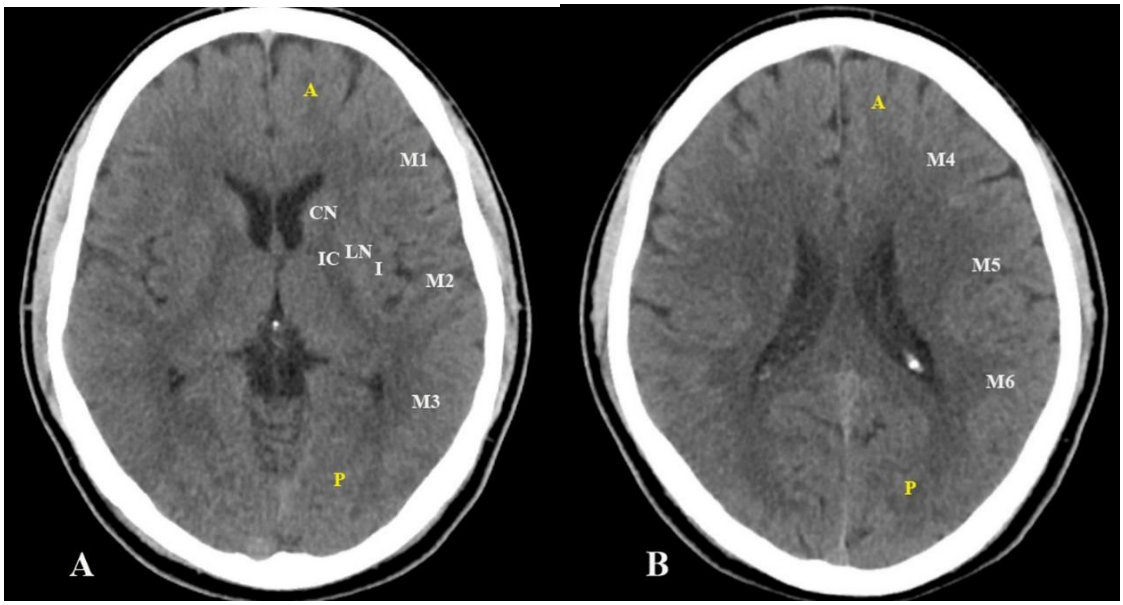
Starting with a score of 10, 1 point is deducted for each of the areas that is involved

If the score is <7, the infarct is considered >1/3 of an MCA territory.

The ASPECTS score has a prognostic significance with score of 7 and above predicting worse functional outcomes at 3 months.

Illustrative examples

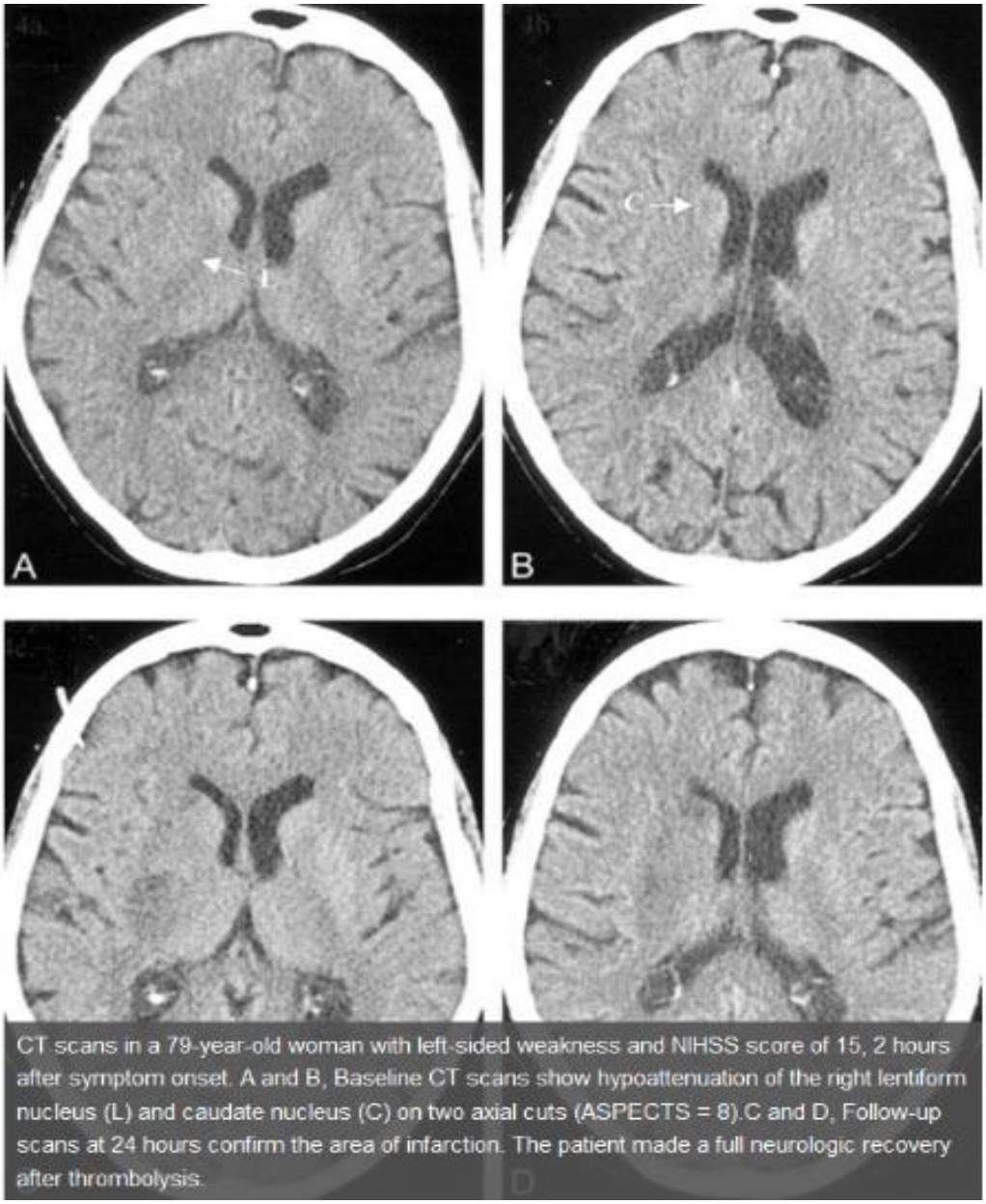
The images below are normal brain CT scans showing the levels at which the assessment for ischemia/ hypodensity is carried out:



Courtesy Dr Owen Kang et al. https://radiopaedia.org/articles/alberta-stroke-program-early-ct-score-1

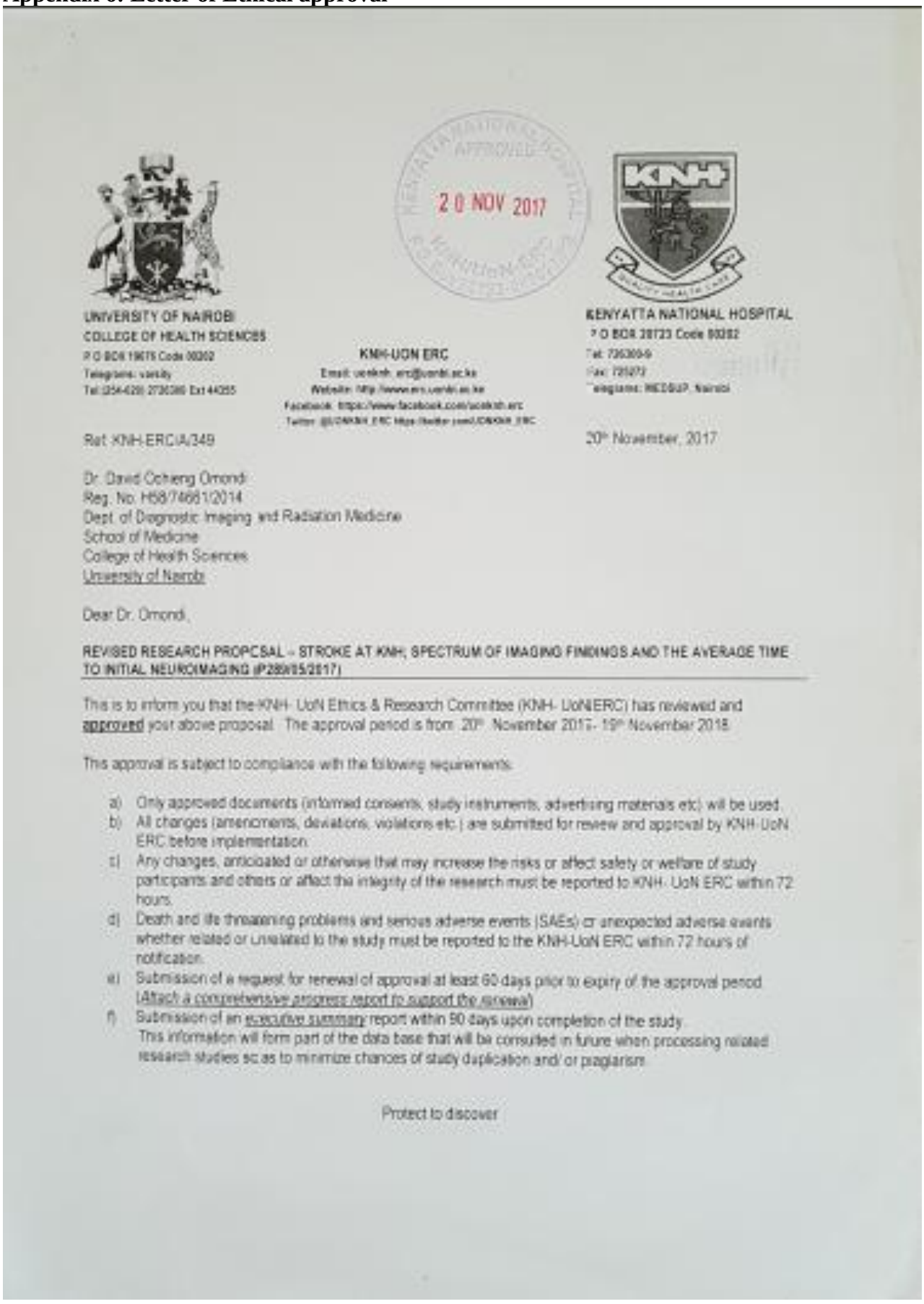
KEY:

- A Anterior
- P Posterior
- I Insular cortex
- IC Internal capsule
- CN Caudate nucleus



From J.H. Warwick et al. Use of the Alberta Stroke Program Early CT Score (ASPECTS) for Assessing CT Scans in Patients with Acute Stroke.
http://www.ajnr.org/content/22/8/1534/tab-figures-data

Appendix 6: Letter of Ethical approval



APPROVED
20 NOV 2017

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Ref: KNH-ERC/A/349

20th November, 2017

Dr. David Ochieng Omondi
Reg. No. H58/74661/2014
Dept. of Diagnostic Imaging and Radiation Medicine
School of Medicine
College of Health Sciences
University of Nairobi

Dear Dr. Omondi,

REVISED RESEARCH PROPOSAL – STROKE AT KNH; SPECTRUM OF IMAGING FINDINGS AND THE AVERAGE TIME TO INITIAL NEUROIMAGING (P289/05/2017)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and approved your above proposal. The approval period is from 20th November 2017- 19th November 2018.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
d) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (Attach a comprehensive progress report to support the renewal)
f) Submission of an executive summary report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

Protect to discover

For more details consult the KNH- UoN ERC website http://www.erc.uonbi.ac.ke

Yours sincerely,

PROF. M.L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Director, CS, KNH
The Assistant Director, Health Information, KNH
The Chairperson, KNH-UoN ERC
The Dean, School of Medicine, UoN
The Chair, Dept. of Diagnostic Imaging and Radiation Medicine, UoN
Supervisor: Dr. Chacha M. (Dept. of Diagnostic Imaging and Radiation Medicine, UoN)

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