THE COST OF ACUTE STROKE CARE AND ASSOCIATED FACTORS IN TERTIARY HOSPITALS ADDIS ABABA, ETHIOPIA

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ABSTRACT

Aim: Stroke is the commonest neurologic ward admission diagnosis in Ethiopia. It creates significant economic burden on the health care system. The acute stroke care cost is a major component of the annual cost for stroke. In this study, we aimed to determine the total acute stroke care cost per patient admitted to a tertiary level government hospital in Addis Ababa, Ethiopia. And to identify components and predictors of the costs in order to better estimate the overall cost of stroke.

Materials and methods: This prospective study was done in Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college on ward admitted patients between December 2020 and October 2021. All ward and ICU admitted stroke patients during the study period were enrolled. Direct and indirect costs from first stroke attack up to discharge were obtained. We used multiple linear regression analysis to determine factors associated with hospital cost.

Results: A total of 118 stroke patients admitted to the study hospitals were enrolled and final analysis was performed on 99 patients. The mean acute stroke care cost per patient at the study hospitals was 14616.5 birr (228.3USD), direct and indirect costs 10209.55 birr (214.4 USD) and 4514. 6 birrs (94.8 USD) respectively. The average length of stay was 9.38 days. Multiple linear regression analysis of the natural log of the total acute stroke care cost showed variation in costs were largely attributable to: the length of hospital stays, ICU admission and rural residence.

Conclusions: Acute stroke care cost in Addis Ababa, government tertiary hospitals are lower than previous African studies. Direct medical cost contributes the majority of acute stroke care cost. Length of hospital stay and ICU admission were the cost driving factors.

Key words: Developing country, Ethiopia, Direct cost, Acute stroke care cost.

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ACRONYMS/ ABRRIVATIONS

LMIC: Low- and middle-income countries

SPI: Sociodemographic index

SPSS: Statistical package for social sciences

RS: Indian Rupee

SSA: sub-Saharan Africa

DALYS: Disability- adjusted life years

USD: US dollar

WHO: World Health Organization

NIHSS: The National Institutes of Health Stroke Scale

Table of content Page

1. Introduction

1.1 Background:

According to the World Health Organization, 15 million people suffer stroke worldwide each year. Of these, 5 million die and another 5 million are permanently disabled [1]. Stroke is a leading cause of death and disability worldwide. Of the 56.9 million deaths worldwide in 2016, more than half (54%) were due to the top 10 causes. Ischemic heart disease and stroke are the two leading causes of death, accounting for a combined 15.2 million deaths in 2016. These diseases have remained the leading causes of death globally in the last 15 years [7]. Since 2008, the incidence of stroke in low-income and middle-income countries (LMICs) has exceeded the incidence in high-income countries [2]. Despite the paucity of high-quality studies, the mostly hospital-based data and limited community surveys indicate there to be high and increasing rates of stroke affecting people at much younger ages in SSA than in developed countries [3].

Stroke is defined according to WHO criteria as rapidly developing clinical signs of focal or global disturbance of cerebral function lasting more than 24 h or leading to death with no apparent cause other than that of vascular origin [8].
Also known as a cerebrovascular disease is a life-threatening and debilitating event in which part of the brain is deprived of essential oxygen and nutrients. There are two main types of stroke: ischemic and hemorrhagic. Ischemic strokes occur as a result of an obstruction within the blood vessels supplying blood to the brain. Hemorrhagic strokes occur when weakened blood vessels within the brain, or the vessels leading into the brain, rupture. In developed countries ischemic strokes are much more prevalent, accounting for 75–85% of all stroke cases. Hemorrhagic strokes represent 15–25% of all stroke cases, with approximately 60% of these being intracerebral hemorrhage and 40% being subarachnoid hemorrhage strokes [9].

But in SSA hemorrhagic stroke is the most prevalent type of stroke reported in limited studies. Study done in different hospital settings in Ethiopia showed that somehow similar result with the one done in Hawassa university referral hospital involving 163 patients, prevalence of ischemic stroke was 50.3% and hemorrhagic stroke 49.7% [10].

In the INTERSTROKE, a case-control study done at 32 locations, found that the risk factors for stroke in low and middle-income countries were similar to those in high-income countries, although the relative contribution of each differed between regions [11].

In SSA, several nonmodifiable risk factors for stroke, such as age, gender, race, ethnicity, and heredity have been identified. Potentially modifiable risk factors include hypertension, atrial fibrillation, hyperlipidemia, Diabetic mellites, cigarette smoking, physical inactivity, and transient ischemic attack (TIA). Although the risk factors for hemorrhagic stroke and ischemic stroke appear to vary considerably between countries, hypertension remains the most important modifiable stroke risk factor globally [12].

While in Sub-Saharan Africa most stroke cases occur in people younger than 60 years of age, in developed countries stroke usually affects much older people of 70-75 years. [13]

Stroke occurs at a younger mean age of 57 years in Africa compared to 66.0 years in high-income countries (HICs); in those ≤ 45 years: 24% in Africa, 8% in HICs) [13].

Hypertension is the strongest risk factor after age and people with hypertension are about 3 or 4 times more likely to have a stroke. The strong association between hypertension and stroke has been attributed to the powerful effects of hypertension on the cerebral circulation [13].

The burden of stroke seems to be shifting to the developing world where currently, there are 4.85 million stroke deaths and 91.4 million DALYs annually compared with 1.6 million deaths and 21.5 million DALYs in high-income countries [13].

Stroke survivors can experience a wide range of outcomes that are long-lasting, including problems with mobility, vision, speech and memory, personality changes and depression. Hemorrhagic strokes tend to kill within the first few days or weeks, whereas ischemic strokes have a better early survival but worse late survival. Effective stroke management is multidisciplinary and includes not only care provided in hospitals but also post-discharge care provided by general practitioners, physician specialists, rehabilitation specialists, trained nursing home staff, community service professionals and caregivers [9].

In the context of low-and-middle income countries, and despite the enormous burden of stroke, only 15% of medical and fundamental research is dedicated to study and explore this medical condition compared to 85% in high-income countries [14].

1.2. Statement of the problem

According to a report from the Global Burden of Disease (GBD) 2016, the estimated global lifetime risk of stroke in 2016 for those aged 25 years or older was 24·9%, an increase from 22.8% in 1990.

The estimate includes an almost equal risk of stroke among women and men, and an 18.3% risk of ischemic stroke and 8.2% risk of hemorrhagic stroke [11].

Additionally, the prevalence of stroke is expected to increase. In a policy statement crafted by an American Heart Association working group, it was concluded that, by 2030, almost 4% of US adults will have had a stroke, accounting for total direct annual stroke-related medical costs increasing from US$71.55 billion in 2012 to $183.13 billion by 2030. Driving the upswing in stroke prevalence rates is a projected increase in stroke attributed to a growing and ageing population and lower stroke case fatality rates associated with better acute ischemic stroke care and improved recurrent stroke prevention strategies. These findings point to the importance of continued surveillance of stroke case fatality, incidence, and recurrence rates.

Despite the reduction in age-standardized stroke death rates and a decrease in stroke incidence in most regions, with the exception of East Asia and southern sub-Saharan Africa stroke is still prevalent and remains disabling.
It has become apparent that population growth and ageing have the potential to result in a greater absolute pool of people at risk of stroke and people who will have a stroke, despite the current declining stroke incidence. A forecast in the USA up to year 2050 suggests a doubling of the number of strokes, largely occurring in people aged 75 years and older and in minority ethnic groups such as Hispanic race. Additionally, improved stroke survival portends a higher prevalence of chronic stroke [8].

In Europe, more than one million of new stroke cases occur each year, and currently six million of stroke survivors are estimated to be alive. In 27 European Union (EU) countries, the annual costs for stroke treatment and care are estimated to be 27 billion euros, with 18.5 billion accounting for direct medical costs and 8.5 billion for indirect costs (e.g., loss of productivity). An additional 11.1 billion euros are estimated to account for informal care. In the USA, a total of $65.5 billion was spent on stroke in 2008, with 67% for direct and 33% for indirect costs [4].

The high burden of stroke worldwide suggests that primary prevention strategies are either not widely implemented or not sufficiently effective. In addition to targeting behavioral risk factors, effective screening for conditions that increase stroke risk, such as hypertension, atrial fibrillation, and diabetes mellitus, is essential. Many screening strategies use the predicted absolute risk of cardiovascular disease to identify individuals at high risk of cardiovascular disease events and to define therapeutic thresholds for specific interventions. However, these approaches have limitations, including low efficiency and missing data for people with low to moderate cardiovascular disease risk, in whom about 80% of strokes occur. Preliminary evidence suggests that strategies via mobile technologies are effective for healthy lifestyle modification and primary stroke prevention. Treatment with statins and blood pressure medications has been shown to be effective and cost-effective for both primary and secondary prevention of stroke. Healthy lifestyle modification and better adherence to recommended medications via an affordable multidrug

polypill containing blood pressure and lipid-lowering medications could potentially also enable cost-effective prevention of stroke globally, potentially halving stroke incidence and mortality[11].

Additionally, we will need to continue to support efforts to prevent stroke by risk factor modification, make stroke prevention available in low-income areas of the world where stroke incidence might be high, and discover novel stroke prevention and rehabilitation strategies [8].

Africa bears the greatest burden of hypertension, which is the strongest and most common modifiable risk factor for stroke [15]. An analysis of all national data in Zimbabwe in the 1990s found that between 1990 and 1997, the national crude prevalence of hypertension increased from one to 4%. According to Adedoyin et al., up to 36.6% of adult Nigerians were hypertensive in 2008[16].

Consequently, strokes are an increasingly important health determinant especially in Africa, where these events were historically reported to be rare likely as a result of lack of resources to conduct proper community-based studies to assess its burden. Despite the proposition that increased stroke occurrence is linked to gains in longevity on the continent, people of African descent clearly experience strokes at a younger age and have worse outcomes. Furthermore, Africa appears to have the highest incidence, prevalence, and case fatality rates of stroke [15].

For example, it is the major neurological cause of admission to hospital in Nigeria, and the third most common cause of admissions to neurological services in Senegal, consuming up to 39% of healthcare resources and staying on average 3 weeks. The cost of stroke care has been estimated 157 US Dollar per episode which is high in fee-for-service countries where most of the population live below the poverty line. Stroke accounts for about 18% of all consultations and 19% of deaths in emergency services in Nigeria [2].
Studies done in India and some other developing countries showed that direct medical cost or acute care of stroke accounted for a major component of cost of stroke. Poor outcome, length of hospital stays, and higher income were the cost driving factors [8].

Even accounting for the uncertainties in the prevalence of HIV/AIDS, as the populations of SSA undergo ageing and other structural changes, the importance of stroke and other non-communicable diseases is likely to increase considerably. Indeed, by 2025, about half of the populations of SSA will live in urban areas and the numbers of people aged 60 years and over will more than double in countries such as the Democratic Republic of Congo, Mozambique, Cameroon, and Ghana. With this rapid demographic transition, stroke is likely to become a more important cause of disability in SSA. Elevated blood pressure is the most frequent and important risk factor for stroke and other CVD, the prevalence of which is estimated to be around 20 million in the SSA. Diabetes mellitus, another risk factor, is rapidly increasing in SSA, driven by urbanization, obesity and sedentary lifestyle [2].
Critical investments are required to improve surveillance and program-relevant research to provide

an evidence base for policy development and effective stroke and CVD prevention and control. Action on stroke and CVD at large in SSA should go beyond just 'primordial' prevention as suggested by some authors [2].

1.3 Justification of the study

Approximately 85% of death from stroke occurs in low to middle income countries. Age and disability adjusted life-years loss rates and stroke mortality rates are 3.5 to 3.8-fold higher in low-income countries than in middle income and high-income countries [5]. African countries are undergoing an epidemiological transition driven by socio demographic and lifestyle changes. The burden of non-communicable diseases (NCD), including cardiovascular risk factors is increasing. Consequently, the incidence of stroke, a cardinal complication of cardiovascular risk factors, appears to be rising in Africa and other low- and middle-income country (LMIC) settings [6].

Strong evidence supports an emerging epidemic of chronic non-communicable diseases, led by cardiovascular disease (CVD), in developing countries as a result of urbanization and demographic re-structuring over the next few decades. However, the situation is often considered different in Sub-Saharan Africa (SSA) where infectious diseases such as human immunodeficiency virus/acquired immune-deficiency syndrome (HIV/AIDS) and malaria are prominent, and expected to remain so for the foreseeable future [17].

As a consequence, there is an apparent reluctance on the part of health funding agencies and policy makers to divert attention and (scarce) resources away from these major health problems into other areas of need. Yet, as in other regions of the world, CVD is anticipated to soon eclipse infectious diseases as the leading cause of death and disability in SSA. In the absence of reliable data, though, it is difficult to assess the size of the potential burden of CVD and develop appropriate strategies to avoid another 'disaster waiting to happen' [2].

The cost of providing acute and long-term care, along with estimated loss of productivity costs in stroke patients, is over 8 billion pounds per year in the UK. Annual costs in the United States reach 33.6 billion dollars, of which 7.6 billion dollars are attributed directly to inpatient stays representing a major economic burden to the health services [18].

Given the economic burden of stroke in the developed countries, a small fraction of such amounts can cause enormous economic damage to low income countries especially in SSA, given the younger age at which stroke occurs [19].

Stroke is a high cost condition, and the majority of stroke-related costs arise from hospitalization. In the first year, approximately 30% of costs for stroke are attributable to acute hospital care and 30% to inpatient rehabilitation. With the expected increases in the incidence of stroke associated with population ageing, finding more effective and cost-effective methods of providing hospital care for acute stroke within an environment of limited resources is important [20].

Stroke impairs all facets of health-related quality of life (HRQOL), particularly domains in the physical sphere (physical, cognitive, psycho-emotional and eco-social domains). The severity of impairment correlates with stroke severity. Many of these disabling strokes occur in young people. Stroke occurs at a younger mean age of 57 years in Africa compared to 66.0 years in high-income countries (HICs); in those ≤ 45 years: 24% in Africa, 8% in HICs) [14].

In a South African study (published in 2012), 25.5% of patients died within three months of discharge and 38% within the 12-month follow-up period. This high fatality rate may be due to the severe scarcity and prohibitive costs of facilities and human resources for investigations, acute care and rehabilitation of stroke patients in Africa [14].

Currently, the most successful and universally applicable intervention for acute stroke in reducing death and disability is organized management in stroke units. Stroke units support greater adherence to evidence-based interventions via a dedicated and specialized interdisciplinary clinical team making them more efficient than general wards [21].

Among these evidence-based interventions is intravenous thrombolytic therapy (IVT) which increases recovery from stroke symptoms by up to 50% with a low serious complication rate. However, only 3% to 8.5% of potentially eligible patients receive IVT [22].

It is also cost saving as showed in a study done on the title cost effectiveness of optimizing acute stroke care service for thrombolysis, it increases quality-adjusted life years gained. Using realistic estimates of effectiveness, the change strategy with the largest potential benefit was that of better recording of onset time, which resulted in 3.3 additional quality-adjusted life years and a cost saving of US $46 000 per 100 000 population [23].

In other way the higher quality of care during the early phase of stroke was associated with shorter LOS among patients with stroke [24]. While direct cost and resources used are typically measured by the length of stay (LOS), which is probably one of the most important quantitative indexes that measures health service utilization within a hospital [24].

IVT decreased the risk of prolonged LOS in patients with acute ischemic stroke regardless of initial stroke severity. Shortening acute-care LOS could help reduce the demand for stroke unit beds and thus improve health care resource allocation [25].

These resources are typically measured by the length of stay (LOS), which is probably one of the most important quantitative indexes that measures health service utilization within a hospital [24]. LOS of ischemic stroke patient differs across single cerebral infarction, lacunar infarction, multi-infarct and brainstem infarction patients. The ascending order of LOS was lacunar infarction, small cerebral infarction, single cerebral infarction, basal ganglia infarction, other subtypes of ischemic stroke, multi-infarct and brainstem infarction [24]. LOS was defined as the difference between

admission to discharge, death or other residential institution. Numerically, it was calculated by discharge date minus admission date [24].

Ethiopia with about 112 million people (2019), it is the second most populous nation in Africa after Nigeria, and the fastest growing economy in the region. However, it is also one of the poorest, with a per capita income of $936.34. Ethiopia aims to reach lower-middle-income status by 2025[26].

Finally, sub-Saharan countries including Ethiopia, where the highest mortality rate and young productive population are being affected in the world due to stroke. while the burden of infectious disease is still high, in the face of standard acute and rehabilitation treatment facilities are limited. So, studies focusing on cost of stroke treatment be it acute or chronic play a great role in diverting attention of government and other stakeholder to focus on effective prevention and treatment of stroke.

Currently knowledge regarding these effective strategies is lacking and given the economic constraints faced by our country, resources must be judiciously used to optimize care for those already affected and to formulate and implement effective strategies to prevent stroke.

2. Literature review

Developing countries have some of the highest stroke mortality rates in the world that account for over two-thirds of stroke deaths worldwide. Hospital-based studies suggest that the patterns of stroke types and causes of stroke differ between developing and developed countries, resulting in differing needs for acute and long-term care. Data on stroke care provision in developing countries are sparse and most of the available studies are biased towards urban settings in reasonably resourced health-care systems. A general overview shows that the quality and quantity of stroke care is largely patchy in low-income and middle-income countries, with areas of excellence intermixed with areas of severe need, depending upon patients' location, socioeconomic status, education, and cultural beliefs [21].

In developing countries, there is great variation in the time taken by patients with stroke to present to hospitals and the imaging or treatment facilities available for their management. Most studies suggest that patients with stroke who present to hospital, do so fairly soon after symptom onset. Studies from The Gambia show that most patients were admitted within 48 h of symptom onset, the median time to admission being 8 h. A study from Ethiopia reported a median time of 13·5 h before presenting to hospital. Studies from urban hospitals in India and the Philippines

report that up to 35% of patients with stroke present within 3 h of symptom onset which is no different to the times to presentation reported from developed countries. Affordability of both investigations and treatment is an important determinant in some settings: only 101 of 1102 (9%) patients with stroke in Nigeria could afford to have CT scans; in Ethiopia, CT scan was only done in 38·3% of patients due to its high price and accessibility. The length of hospital stays varied substantially according to region and affordability. The median hospital stay in Pakistan was only 3 days compared with 32 days for insured patients in China. There is very little information on specialized stroke-unit care in developing countries [21].

As mentioned in the above researches the economic cost of acute and chronic care determined by factors including: disease awareness, duration of time to emergency presentation from onset of symptoms which indirectly affect economic burden by resulting suboptimal improvement due to delayed intervention, affordability and access of investigation and treatment options, length of hospital stay and access to and availability of adequate rehabilitation facilities.

Post stroke medical complications are also determinant factors of cost of acute care. It is a common problem as it is shown in this study done in tertiary hospitals at Addis Ababa. Stroke-complications were detected in 71.8% (51/71) of the study participants and the most frequent complication was aspiration pneumonia which occurred in 33.8% (24/71). Miscellaneous complications such as sepsis, hypokalemia exposure keratitis was detected in 25% (17/71) of stroke patients. Complications were more common in patients with severe neurologic deficit as measured by Glasgow coma scale (GSC) and old age [31].

In Singapore ward costs, which consist of total operational charge, daily fee, facilities charges and ward charges, accounted for 48.1% of total overall charges. This was followed by laboratory investigations (18%), radiological investigations (12.8%), medications (9.2%), services rendered (8.6%), miscellaneous (1.9%) and expert care (1.5%). Mean total charges for the overall population were S$6,783 (median S$4,238; range S$246–S$119,042). Mean daily average charges were S$769 (median S$668; range S$203–S$13,967 [27].
In the same study the number of hospitalizations as a result of ischemic stroke has been on the increase. In 2007–2008, the mean total cost of hospitalization in this study was S$6,783 and the average length of stay was 12.3 days. Ward costs accounted for 48.1% of the total cost. Length of stay accounted for 76% of the variability in total cost. Length of stay was significantly different between patients with different discharge destinations and dependent on whether inpatient rehabilitation was provided. They found that total cost was significantly influenced by age, LOS, whether the patient received inpatient rehabilitation and the discharge destination after adjusting for potential confounding factors [27].

In one Indian study, the overall cost of stroke (ischemic and hemorrhagic stroke) was Rs (Indian rupee) 80612 (US $1520). Patients stayed for a longer time in the hospital in this study as

compared with studies from Taiwan and Singapore but shorter than a study conducted in China. The length of hospital stay in this study was longer because of their intensive ongoing in hospital rehabilitation program [8].

Depending on the severity of the stroke and its consequences, patients may need constant care for the remaining lifetime. Therefore, the clinical and economic burden of the disease contributes to significant public health relevance. As reported by the National Stroke Association, 40% of all patients acquire moderate to severe impairments and need special care, while 10% require constant care in long-term care facilities. For the years 2001–2005, the average cost for medication and for outpatient stroke rehabilitation services in the first year after discharge were $11,145 per patient with $7318 spent for rehabilitation services and $3376 for medication. Many studies have found high direct costs associated with stroke, including costs for inpatient stays, outpatient visits, rehabilitation, medications, and nursing home, etc. For example, total annual direct costs were estimated at $22.8 billion in 2009 for the US and €26.6 billion in 2010 for the EU plus Iceland, Norway, and Switzerland. Far fewer studies have considered the indirect costs of stroke, including productivity loss due to morbidity and mortality, and costs of informal caregiving usually provided by unpaid family members, although the indirect costs have been claimed to be large [1].

The American Heart Association and The American Stroke Association projected for the years 2012 to 2030, that the total direct medical cost for stroke will triple and reach up to $184.1 billion [17].

Other study done in Turkey, the average direct cost and indirect cost per patient were calculated respectively as 10,594.90±6,554.20 Turkish liras and 9,357.10±10,195.60 Turkish liras (4,606.4±2,849.65 USD and 4,068.30±4,432.86 USD). They found a negative correlation between total cost and age (p=0.001), and a positive correlation with duration of hospitalization (p=0.001) and number of complications (p=0.049). They were unable to find any relation of cost with sex and cerebrovascular accident type. Spasticity (p=0.028) and epilepsy (p=0.037) being among the complications were observed to increase the cost [28].

South African rural area setting study, the total direct costs of stroke were estimated to be R2.5–R4.2 million (US$283,500–US$485,000) in 2012 or 1.6–3% of the sub-district health expenditure. Of this, 80% was attributed to inpatient costs. Total costs were most sensitive to the underlying incidence rates and to assumptions regarding service utilization [29].

In other pilot study done in Nigeria, the results revealed that it requires an average of N95,100: 00 ($600) and N767,900: 00 ($4860) in a government and a private hospital, respectively to access care within the first 36 weeks of post stroke affectation [30].

A systematic review on cost of stroke in low- and middle-income countries: founds that costs of stroke are variable because of heterogeneous healthcare systems prevailing in low and middle-income countries. Length of hospital stay and stroke severity appear to be the main predictors of cost. Understanding the costs of stroke in low and middle-income countries is important. The

highest mean direct medical cost of stroke was US$ 8424 in Nigeria. The lowest mean cost of stroke was in Senegal (US$ 416). The average length of hospital stay was longest (20 days) in China. The main predictors of higher costs appeared to be due to differences in length of stay and stroke severity. However, the evidence remains limited because there is a lack of standardized research. Future research should focus on using a uniform method across low- and middle-income countries for estimating the costs of stroke [19].

There are very few studies on the cost of stroke care in Africa among those a study in Togo estimated direct cost per person of 936 Euros in only 17 days, about 170 times more than the average annual heath spend of a Togolese. Subsidizing and improving poststroke care may help to reduce stroke case fatality rates and morbidity in Africa [14].

In our setting there is no a single research on cost of stroke care neither acute inpatient nor chronic rehabilitation costs. studying health care cost including stroke in developed countries much easier than our set up because it is possible to calculate health sector costs and productivity losses related to diseases because information from public and private hospitals, general practice, and privately practicing specialists, and data about medication, social transfers, labor market income and employment for are registered in central databases. But still it possible to conduct a study which assesses acute inpatient stroke care cost until stabilization and discharge, which is the focus of this proposal.

3. General objective

To assess cost of acute stroke care in Tikur Anbesa specialized hospital and Yekatit -12 Hospital medical college.

3.1. specific objective

1. To assess direct cost of acute stroke care in Tikur Anbesa hospital and Yekatit-12 Hospital medical college

2. To assess indirect cost of acute stroke care in Tikur Anbesa hospital and Yekatit-12 Hospital medical college.

3. To identify factors influencing cost of acute stroke care

3.2 Variables

Independent Variable

- Social-demographic variables
- Age
- Sex
- Sex of the patient
- Educational status
- Marital status
- Job of the patient
- Place of residence
- Type of stroke
- Place of investigation/first health care visit (private/ government hospital)
- Presence of medical complications.
- Length of hospital stay
- Presence of other comorbid illness
- Severity of stroke

Dependent variables

- Cost of acute Stroke care

4. Research method and materials

4.1 Study setting and period

The study was carried out at Addis Ababa university, Tikur Anbesa specialized hospital and Yekatit - 12 hospital medical college which are public health facilities found in Addis Ababa, Ethiopia. Addis Ababa is the capital city of Ethiopia found at the center of the country and it has ten sub cities.

Based on the 2007 census conducted by the Ethiopian national statistics authorities the population of Addis Ababa is 3,384,569 million; all of the population is urban inhabitants. For the

capital city 662,728 households were counted living in 628,984 housing units, which results in an average of 5.3 persons to a household.

Addis Ababa lies at an altitude of 2,300 meters and it covers an area of 526.47km2. Tikur Anbessa Specialized Hospital which serving currently 300 to 400 thousand patients annually. It is found in Lideta Sub City which covers an area of 9.18 km2 with a total population of 214,769.

Yekatit-12 hospital medical college is found in Arada Sub city, Addis Ababa, Ethiopia. Which covers an area of 30.1 km square with a total population of 284,865. Yekatit -12 hospital medical college serves more than half a million people primarily from two sub cities as a referral hospital providing the community with different preventive, curative and rehabilitative health services.

5. Sample and study population

A prospective cross-sectional study with convenience sampling method was conducted among patients who are admitted using structured questionnaires. All patients seen or admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college with an imaging confirmed diagnosis of stroke within operational time frame were included in the study. Data were collected for ten months duration between December/2020 G.C and November /2021G.C from the patients, their attendants and for some clarity supportive data sought form patients' chart and health care provider if needed.

5.1 Study population /source population:

The target population for this study will be all patients seen or admitted in both hospitals with an imaging confirmed diagnosis of stroke in the given time.

5.2 Inclusion criteria

a) All patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college with an imaging confirmed diagnosis of stroke and age greater than or equal to15 years.

5.3 Exclusion criteria

a) Stroke Patients who are seen as outpatient and died at emergency before admission.

b) All stroke patients beyond 30 days post stroke.

C) Patients who didn't complete their medical care due to different reasons.

5.4 Sampling size and sampling procedure:

The convenient method employed to involve all stroke patients admitted to Tikur Anbessa specialized hospital and Yekatit-12 hospital medical college, between December, 2020 and November, 2021 will be included in the study.

5.5 Study Instrument:

A closed ended structured questionnaire which contains information on the socio-demographic characteristics such as age, religion, educational status, marital status, address, job, type of stroke, place of investigation etc...

5.6. Data Collection procedures:

A closed ended structured questionnaire was prepared by reviewing previously done studies on the topic of cost of stroke care. The questionnaire was prepared in English and translated to Amharic during data collection to create a better and uniform understanding. The questionnaires were distributed to the trained data collectors by the investigator and were advised to seek help on clarity issues. The variables were tested including diagnosis, type of stroke, co morbid illness, length of hospital stay, place of investigation and first hospital visited (private/government set up). The questionnaires were collected from data collectors for inspection to ensure completeness and legibility.

5.7. Minimizing errors

a) Questionnaires were pretested.

b) Data collectors and participants were provided with an opportunity to seek clarification.

c) Data collectors were monitored so that exchanging of information does not take place.

5.8. Operational Definition

Acute stroke case: Was considered from the day of incidence of stroke through day 30 after the event. Stroke cases will be considered chronic (prevalent) from 31 days after the occurrence of an event.

Chronic stroke: Included here the sequelae of an acute stroke beyond the first month. 30 days is selected as the cutoff between acute and chronic stroke because this corresponds to the period of early case fatality.

Transport cost: All transport costs of current illness from home until the patient reaches to the study hospitals.

Other cost: Costs paid for the current illness medical care before reaching to the study hospitals.

Direct cost: Amount of money payed for the treatment of stroke in emergency or inpatient setting with in the first 30 days.

Indirect cost: Any income missed or money payed due to the stroke be it from the patient or his care giver other than direct cost.

Informal caregiver is defined as care giver either relatives or unpaid non-relatives not in an organization to help a patient to complete their activities of daily living.

5.9. Ethical considerations

Ethical approval and clearance were taken from the Ethical review Committee of Neurology department, Tikur Anbesa specialized hospital. The purpose of the study was explained to Neurology department.

a) The research proposal was submitted to department of neurology for approval.

b) Permission to conduct the research was sought from the respective hospital's authorities.

c) Voluntary consent was obtained from the participants.

d) Purpose of the study, its benefits and risks clearly explained to the participants.

e) Confidentiality of all information were guaranteed.

f) Names were not written on the questionnaires

5.9.1. Study benefits

a) The results will aid in the designation of intervention programs against stroke.

b) To recommend on prioritizing prevention measures

c) The Research report will be submitted in partial fulfillment of the requirements for specialty in neurology.

5.9.3. Data quality control measures:

Data were collected by the trained data collector within the specified period of time by utilizing a closed ended structured questionnaire. The Questionnaires were tested to assess for its clarity, understandability, flow and consistency, and revised prior to the starting of data collection. To decrease recall bias patients and their attendants were informed about the type of data that we are dealing and to have prepare themselves since the day of admission. Data completeness and consistency was checked by the investigator. Data cleaning and editing was done.

6. Data Processing and Analysis:

Data were entered and analyzed using SPSS version 25. Descriptive statistics was carried out to explore the socio-demographic characteristics of respondents, other cost determinant factors and the results summarized as frequencies and percentages between Clients or subjects who used the service and those who did not utilized. To determine which factors were associated with stroke cost binary and multiple logistic regressions was employed. Variables associated with cost of stroke bi-variate analyses were included in the multiple logistic models and P-values less than 0.05 considered to be statistically significant in all cases. For free patients' cost was calculated based on institution's cost bill where they get the service.

Estimation of cost associated with informal caregivers was done by taking average daily laborer salary, using a replacement approach which assumes that informal caregivers substitute activities of (formal) paid workers.

7. Dissemination and Utilization of Results:

The results obtained at the end of the research of this study will be presented to Tikur Anbesa specialized hospital, Neurology department; findings will be shared with Addis Ababa Regional Health Bureau, MOH, as well to all stakeholders working on non-communicable disease. Efforts will be made to present the results on scientific conferences and peer reviewed journal publications will be considered in the future.

8. Results

8.1. socio-demographic data

Among a total of 118 participants, 99 patients are included in the study and 19 patients were excluded from the study due to incomplete data making the respondent rate of 84 %.

Age distribution of the participants majority of them 43 (43. 4%) were between 61 to 80 years old and the remaining in decreasing order 31 (31.1%), 14 (14.1%) and 11 (11.4%) were between 41-60, 15-40, and above 80 years old respectively. Among the total patients 57 (57.6%) were male and 42(42.4%) were female and other socio-demographic data are shown in table 1.

Table 1. socio demographic data of stroke patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variables		Frequency	Percentage	Variables		Frequency	Percentage
Age (years)	*14-40*	14	14.1	Marital status	*Married*	64	64.6
	41-60	31	31.3		*Divorced*	7	7.1
	61-80	43	43.4		*Single*	7	7.1
	>80	11	11.4		*Widowed*	17	17.2
					Others	4	4
Gender	*Male*	57	57.6	Educational status	*Illiterate*	31	31.3
					Only read and write	20	20.2
					Primary school	12	12.1
	Female	42	42.4		*Secondary school*	23	23.2
					College	13	13.1
Residency	*Urban*	77	77.8	Occupation	*Unemployed*	30	30.3
	Rural	22	22.2		*Employed*	10	10.1
Religion	*Orthodox*	76	76.8		*Student*	1	1
	Muslim	15	15.2		*Private*	42	42.4
	Protestant	7	7.1		*Retired*	16	16.2
	Catholic	1	1				
	Others	0	0				

8.2. Clinical characteristics of respondent patients

Majority of participant patients have comorbid illnesses 62 (72.1%). And only 9 (10.5%) have previous stroke.

Ischemic stroke (including cardioembolic stroke) was the commonest type of ward admission diagnosis. Severity of stroke was assessed by NIHSS scoring tools and the findings.

Table 2. Clinical characteristics of stroke patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variables		Frequency	Percentage
Diagnosis	*Acute ischemic stroke*	67	69.7
	Hemorrhagic stroke	32	32.3
History of previous stroke	Yes	9	9.1
	No	90	90.9
Medical complications	*Aspiration pneumonia*	16	16.2
	Urinary tract infection	5	5.1
	Other complications	4	4
	No complication	74	74.7
Admission NIHSS score	*Minor (1-4)*	26	26.3
	Moderate (5-15)	46	46.5
	Moderate to severe (16-20)	17	17.2
	Severe (21-42)	10	10.1
Place of admission	*Ward*	95	96
	ICU + ward	4	4
Co-morbid illness	*Yes*	69	69.7
	No	32	32.3

The length of hospital stays, the total duration from admission to discharge while the patient getting an inpatient care at ward, ICU or both. The mean length of hospital stay was 9.38 days

8.3. Direct costs of acute stroke care cost.

Direct costs refer to all the goods, services and other resources that are consumed during the provision of a health intervention for a certain illness.

Acute stroke care in tertiary hospital usually include routine laboratory investigations such as complete blood count (CBC), serum electrolyte, liver and renal function tests, lipid profile, coagulation profile, electrocardiogram (EKG), echocardiogram, carotid Doppler ultrasound, neuroimaging of brain (CT scan, MRI scan or both) and medical management in stroke care unit.

In this study the total direct acute stroke care cost includes the sum of transport, investigation, medication, inpatient service costs and including other health institution visit costs for the current illness.

Table. 3. Components of Direct and indirect acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Cost	Direct cost						Indirect cost			SUM
	Transport	Investigation	Medication	Service	Other	Sum	Patient's	Care givers'	Sum	TOTAL
Mean	1130.9	3632.2	2081.5	2265.8	1170.5	10209.5	1050.4	3479.4	4514.6	14616.5

Table 4. Direct acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variable	Min	Max	Mean	Median	Std. deviation	25th percentile	75th percentile
Direct acute stroke care cost	2468	37414	10209.55	8588.0	6511.9	5519	11,898

8.4. Indirect costs of acute stroke cost

Indirect costs are defined as production losses due to an illness. They represent the monetary value of the production losses due to absenteeism of the patient and his/her caregiver during acute stroke care. And total indirect cost is the sum of patients indirect cost and attendants indirect cost.

Table 5. Indirect cost of acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variable	Min	Max	Mean	Median	Std. deviation	25th percentile	75th percentile
Indirect acute stroke care cost	0.00	18000.0	4514.6	3280.0	3874	1640	6600

8.5. Total acute stroke care cost

Which is the sum of direct and indirect stroke care costs and the mean value being 14616.5 birrs per individual patient.

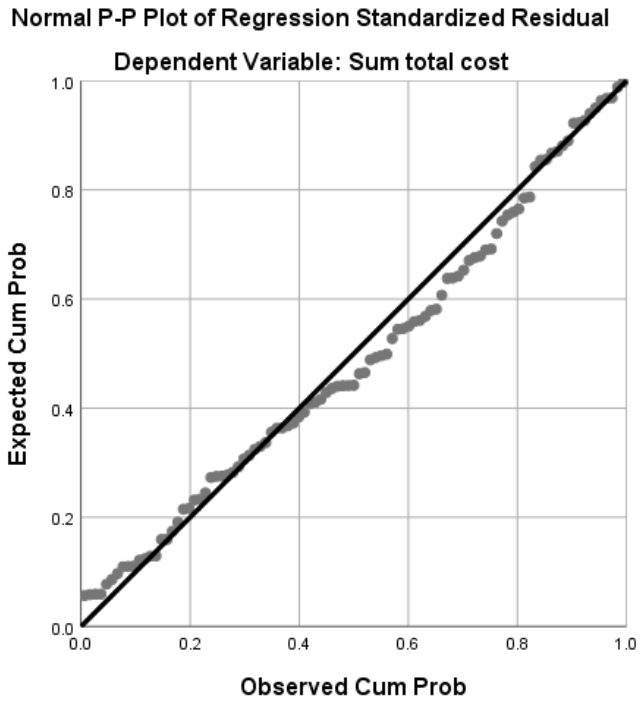
Table 6. Total acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

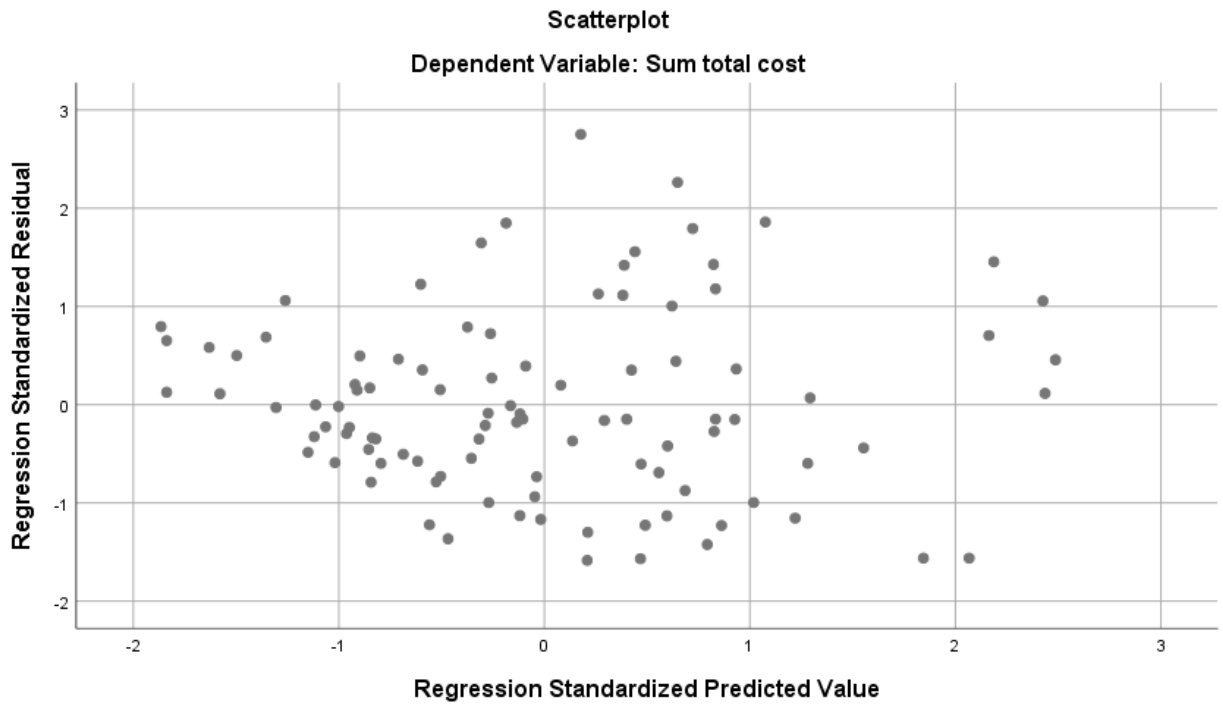
Variable	Min	Max	Mean	Median	Std. deviation	25th percentile	75th percentile
Total acute stroke care cost	3168	37541	14616.5	12679	8529.1	7191.0	19468.0

8.6. Factors associated with total acute stroke care cost

Bivariant and multi variant linear regression analysis was done after checking all assumptions of linear regression including linearity and normality. Variables are acceptably linear and normally distributed and there are few outlier values. There is no issue of multiple collinearity as shown on the following graphs.

Graph 1. Normal p-p plot




Scatterplot
Dependent Variable: Sum total cost
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-2
-1
0
1
2
3

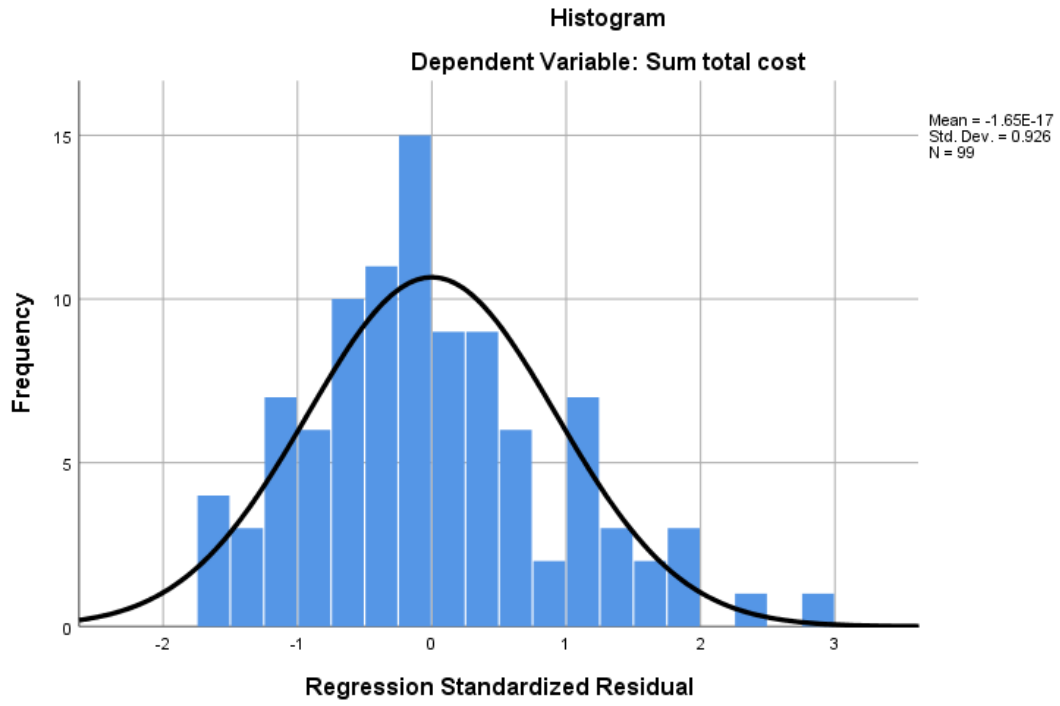

Histogram
Dependent Variable: Sum total cost
Mean = -1.65E-17
Std. Dev. = 0.926
N = 99
Frequency
Regression Standardized Residual
15
10
5
0
-2
-1
0
1
2
3

Table 6: Collinearity statistics of dependent and independent variables of acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variables		Unstandardized Coefficients		Sig.	Collinearity Statistics	
		B	Std. Error		Tolerance	VIF
	(Constant)	536.596	10029.245	.957		
	Admission diagnosis	-1281.815	1384.860	.357	.809	1.235
	Medical complication	-376.875	607.580	.537	.705	1.418
	Age	1306.396	757.176	.088	.785	1.274
	Gender	-72.362	1826.211	.968	.417	2.399
	Address	4806.665	1667.175	.005	.707	1.415
	Marital status	-94.974	500.846	.850	.771	1.297
	Religion	-1482.161	953.724	.124	.887	1.127
	Educational status	913.825	512.445	.078	.615	1.625
	Occupation	472.445	514.699	.361	.538	1.858
	Comorbid illness	-820.540	1517.979	.590	.698	1.433
	Length of hospital stay	1007.803	157.528	.000	.566	1.765
	Place of admission	4108.862	1906.634	.034	.740	1.352
	Number of previous strokes	-1828.953	2149.265	.397	.889	1.124
	Admission HINSS score	-976.593	795.410	.223	.650	1.539

Linear regression of individual variable was done. And variables which have statistically significant association with the outcome variable includes length of hospital stay, medical complications, residence, place of admission, NIHSS score and comorbid illness with p- value of <0.05).

Table 7. Bivariant analysis of independent and dependent variables of acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variables	Coefficient (B)	Standard error	Significance (p-value)	95 % standard interval for B	
				Lower bound	Upper bound
Age	1101.2	985.4	0.267	-854.5	3056.9
Gender	-1894.4	1732.7	0.277	-5333.4	1544.5
Residency	6992.5	1947.1	0.001	3128.1	10856.9
Marital status	-766.5	645.6	0.238	-2047.9	514.9
Educational status	536.1	591.9	0.367	-638.7	1710.8
Religion	-2053.28	1311.8	0.121	-4656.9	550.3
Occupation	-568.9	555.2	0.308	-533.1	1670.9
Co-morbid illness	-5164.4	1800	0.005	-8736.9	-1591.9
Previous stroke	-4947.9	2954.7	0.097	-10812.3	916.3

Admission diagnosis	-4330.1	17889	0.017	-7880.6	-779.5
Place of admission	5466.9	2359.9	0.023	783.1	10150.6
NIHSS score	2468.1	914.3	0.008	654.6	4283.6
Medical complications	-2631.6	705.4	0.000	-4031.6	-1231.6
Length of stay	1170	128.9	0.000	914.2	1425.9

Strongest association seen with length of hospital stay with coefficient of (B-value 1170) and P-value of <0.001) it has strong correlation and 45.9% prediction rate. The other clinical variable which shows significant association with total stroke care cost is medical complication. Form the medical complications aspiration pneumonia is associated with 7835.5 times (B- value of 7835.5) increased cost of acute stroke care cost but low prediction rate 11.6%. The remaining medical complications didn't have statically significant association with the cost. Absence of medical complication associated with 6648.5 times decreased cost of acute stroke care with p- value of 0.001 but prediction rate is low 11.6 %.

Patients from rural area when compared with those from urban area had 6992.6 times increased cost of acute stroke care with p- value of 0.001 again with 11.7% prediction rate.

Patients who were admitted to ward had strong association with decreased cost with (B – value of -11173.9) and p value of 0.010with 6.7% prediction rate. ICU admission is associated with increased cost with the same prediction value.

Severity of stoke as assessed by NIHSS score, doesn't show statistical significance association except mild stroke patients tend to have low stroke care cost with p- value of 0.027 with prediction rate of 5%. Severe, moderate to severe, and moderate stroke with p- value of 0.22, 0.76, 0.00 respectively.

Presence of comorbid illness also showed statistically significant association with increased cost of acute stroke care (p- value 0.05) and B – value of 5164.4 with 7.8% prediction rate. Ischemic stroke has statistically significant association with increased cost of stroke care with p- value of 0.017 and prediction rate of 5.7 %

On multivariant analysis independent variables which strongly predict cost of acute stroke care cost were length of hospital stay, ICU admission and rural residence with p- value of <0.001, 0.001, 0.014 respectively.

Table 8. Multivariant analysis of independent and dependent variables of acute stroke care cost of patients admitted to Tikur Anbesa specialized hospital and Yekatit-12 hospital medical college in the study period.

Variables		Unstandardized Coefficients		Sig.	95.0% Confidence Interval for B	
		B	Std. Error		Lower Bound	Upper Bound
	Rural residence	3837.984	1523.222	0.014	811.837	6864.131
	ICU admission	11371.449	3369.397	0.001	4677.554	18065.345
	Length of Hospital stay	1076.493	151.741	0.000	775.034	1377.953

9. Discussion

Stroke care is globally large economic burden which includes both acute in-patient treatment, rehabilitation and disability and problems with activities of daily living.

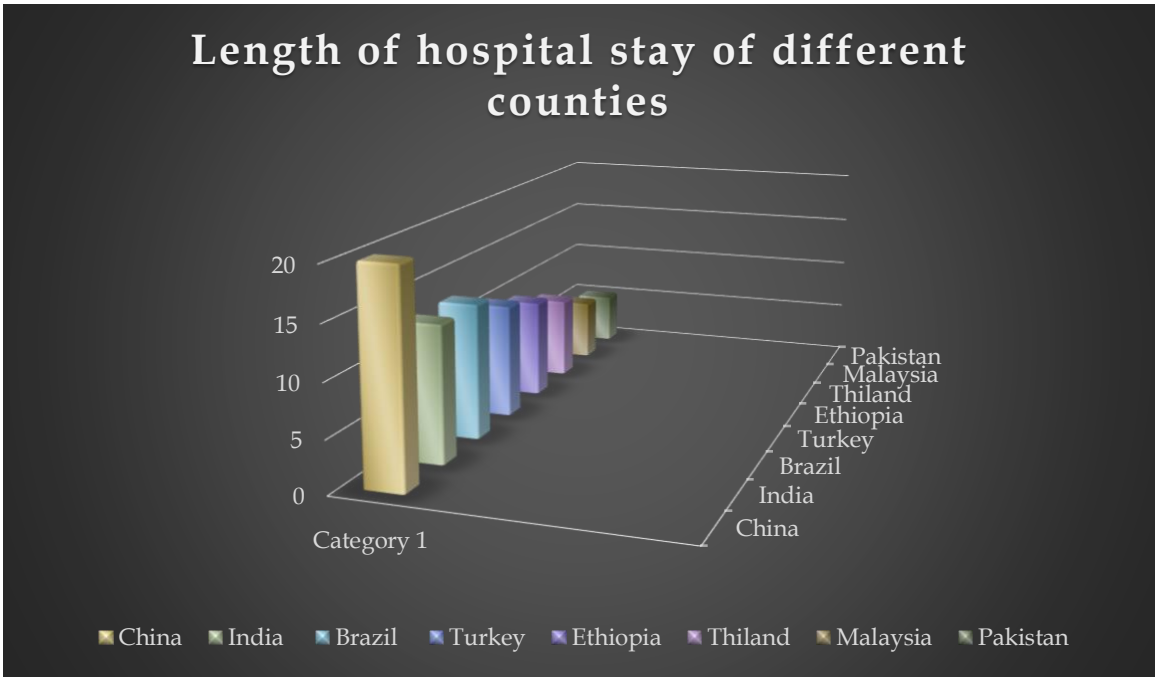
Improved acute stroke care decreases long-term disability and it has a beneficial impact on economic burden related to stroke. Cost studies helps to understand the economic impact of stroke and enable policy makers to understand the costs of stroke and better allocate health care resources. This study is, to the best of our knowledge, the first to systematically assess costs of acute ischemic stroke in Ethiopia. In this study the cost of acute stroke care is variable and strongly related to the length of hospital stay and ICU admission both of which could probably relate to severity of the stroke. The mean total direct medical cost per admission is 14,616 birrs (228.3 USD) and the mean direct and indirect costs 10,209.55 (214.4USD) and 4514.6 (94.8USD) birr respectively. Direct cost covers about 69.8 % of the total acute care cost which very close to Indian study which was 65% [8].

The cost for acute stroke care per admission in China has been reported to be 903 USD [50], for Pakistan to be 1,179 USD [51], for Taiwan to be USD 1,798 (Chang and Tseng, 2003), for Singapore to be 4,984USD [52], and for Japan to be 6,887 USD [53].

A breakdown of direct and indirect acute stroke care costs in our study showed the major cost component was the investigation with mean cost of 3632.25 birr which is 24.8% of the total cost followed by attendant's indirect cost 3479.4 birr (23.8%). Service cost 2265.8 birr (15.5 %) and medication costs 2081.5 birr (14.2 %) were the third and fourth major component of acute stroke care cost. These main cost components different form previous international studies were ward cost was the major component in Thailand, Singapore and japan with 57.6%, 38.2% and 69% respectively [52, 53, 54]. The highest investigation cost in our study can be explained by, since all the study hospitals didn't have complete imaging and laboratory tests patients were sent to private diagnostic centers and laboratories.

African studies as published by world stroke foundation in 2014, in Nigeria government hospital direct stroke care cost was 1043. USD (Current 1126.44 USD considering inflation value.) and in Senegal 416USD (430.68 USD corrected current amount) [19]. Our result of direct stroke care cost 10,209.55 birr (214.4USD) is less than from the lowest value (i.e. Senegal's: 430.68 USD) of previous studies. This can be explained by low medical cost and low GDP per capita of Ethiopia (936.34 USD) when compared with Senegal (1487.76 USD).

The mean length of hospital stays 9.38 days. The mean daily acute stroke cost will be mean total acute stroke care cost divided by mean length of duration of hospital stay which is 9.38 days, become 1,088.4 birr. Length of hospital stay which is strongest acute stroke care cost determining factor, in this study is nearly the average of previous studies [19].



The present cost of stroke can be reduced by decreasing the length of hospital stay. This could be achieved by implementing early supported discharge and home-based rehabilitation.

ICU admission either because of severity of stroke or presence of other medical complications/ comorbid illness associated with increased acute stroke care cost. In addition, service costs are higher in medical ICU than ward services. All these explain the increased cost of ICU admitted patients.

Significant effect of rural residence on the out come variable can be explained by transport cost and usually people from the rural side tend to have more than one attendant which directly increases the indirect cost. The other explanation is they have to pass through a number of

referrals from each level of health care unit to reach to tertiary hospital, which directly increases the direct cost.

Type of stroke doesn't show significant impact on the total acute stroke care cost. Which is the case in Indian and Malaysian studies [19].

10. Conclusion

Cost of acute stroke care in Ethiopia government tertiary hospitals, is low when compared with previously done African studies. But this amount of many is very high in a country like Ethiopia where the average monthly salary of 8900 birr (186.9 USD). Costs of stroke care are variable because of heterogeneous healthcare systems prevailing in developing countries. Length of hospital stay, ICU admission and rural residence appear to be the main predictors of acute stroke care cost.

11. Limitation of the study most of the study

This study was two tertiary hospital-based analysis of acute stroke care cost care in Addis Ababa, Ethiopia. Nationwide studies are apparently more representative, further studies are necessary to evaluate economic burden of stroke care in the Ethiopia. In addition to this the following are major limitation of this study:

1. Patients with mild stroke were more likely to be discharged home after having their investigations, and acute treatment usually within few days of admission as low as one day. This skewed the group of patients examined and could lead to underestimation of the cost.

2. Findings in this study might not be representative of acute stroke care cost in government tertiary hospital because many patients had imaging and laboratory investigations in private laboratories and diagnostic centers.

3. Small sample size is also limitation of this study.

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