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ORIGINAL ARTICLE

The burden of acute coronary syndrome, heart failure, and stroke among emergency department admissions in Tanzania: A retrospective observational study

Julian T. Hertz[a,e,*], Francis M. Sakita[b], Alexander T. Limkakeng[a], Blandina T. Mmbaga[c], Lambert T. Appiah[d], John A. Bartlett[e], Sophie W. Galson[a]

[a] Division of Emergency Medicine, Duke University, 2301 Erwin Rd, Durham, NC 27710, United States of America
[b] Department of Emergency Medicine, Kilimanjaro Christian Medical Centre, PO Box 3010, Moshi, Tanzania
[c] Kilimanjaro Christian Research Institute, Kilimanjaro Christian Medical University, PO Box 3010, Moshi, Tanzania
[d] Department of Cardiology, Komfo Anokye Teaching Hospital, PO Box 1934, Kumasi, Ghana
[e] Duke Global Health Institute, 310 Trent Drive, Durham, NC 27710, United States of America

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ABSTRACT

Introduction: The prevalence of cardiovascular disease in sub-Saharan Africa is substantial and growing. Much remains to be learned about the relative burden of acute coronary syndrome (ACS), heart failure, and stroke on emergency departments and hospital admissions.

Methods: A retrospective chart review of admissions from September 2017 through March 2018 was conducted at the emergency department of a tertiary care center in northern Tanzania. Stroke admission volume was compared to previously published data from the same hospital and adjusted for population growth.

Results: Of 2418 adult admissions, heart failure and stroke were the two most common admission diagnoses, accounting for 294 (12.2%) and 204 (8.4%) admissions, respectively. ACS was uncommon, accounting for 9 (0.3%) admissions. Of patients admitted for heart failure, uncontrolled hypertension was the most commonly identified etiology of heart failure, cited in 124 (42.2%) cases. Ischemic heart disease was cited as the etiology in only 1 (0.3%) case. Adjusting for population growth, the annual volume of stroke admissions increased 70-fold in 43 years, from 2.9 admissions per 100,000 population in 1974 to 202.2 admissions per 100,000 in 2017.

Conclusions: The burden of heart failure and stroke on hospital admissions in Tanzania is substantial, and the volume of stroke admissions is rising precipitously. ACS is a rare diagnosis, and the distribution of cardiovascular disease phenotypes in Tanzania differs from what has been observed outside of Africa. Further research is needed to ascertain the reasons for these differences.

African relevance

- Acute coronary syndrome is a rare admission diagnosis in Northern Tanzania
- Heart failure and stroke were the most common admission diagnoses.
- The burden of stroke admissions appeared to be rising rapidly.

Introduction

Cardiovascular diseases such as acute coronary syndrome (ACS), heart failure, and stroke are the leading causes of years of life lost worldwide [1], but much remains unknown about the epidemiology of these diseases in sub-Saharan Africa (SSA). Although only a few studies of stroke incidence have been performed in SSA, there is growing evidence that the burden of stroke in the region is substantial and rising [2–4]. Estimations from recent studies have found that the incidence of stroke in many parts of SSA is higher than in many high-income countries [5,6].

Little is known about the incidence of ACS in SSA. A recent systematic review found only a few small and methodologically-limited studies describing the burden of ACS in the region [7]. Rigorous, large-scale ACS epidemiological data remains lacking for most of SSA. The sparse data available has suggested that ACS is a relatively uncommon diagnosis in SSA [8], leading some to conclude that stroke is the dominant form of cardiovascular disease in SSA [9,10]. The apparent

* Corresponding author at: Duke Global Health Institute, Box 102359, Duke University, Durham, NC 27710, United States of America.
E-mail address: julian.hertz@duke.edu (J.T. Hertz).

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paucity of ACS relative to stroke in SSA is peculiar, given evidence from settings outside SSA that cerebrovascular disease is highly correlated to ACS risk [11–14]. However, the true differences in the relative burden of stroke and ACS in SSA and the reasons for such a discrepancy in comparison to other world regions are unknown.

Heart failure is a well-described phenomenon in SSA, although rigorous population-based prevalence and incidence studies are lacking [15,16]. Heart failure in SSA is known to have very different etiologies than in other regions of the world; numerous studies have demonstrated that heart failure in SSA is primarily due to hypertension and cardiomyopathies, with ischemic causes being rare [8,17–19]. Less is known about the overall burden of heart failure on inpatient resources in SSA, particularly in East Africa [15,16].

Much remains unknown about the relative burden of stroke, ACS, and heart failure in SSA, three cardiovascular diseases which share common risk factors. There has been speculation that a combination of genetic factors, environmental influences, or different risk factor profiles has resulted in a predilection for certain cardiovascular diseases (such as stroke and hypertensive heart failure) versus others (such as ACS and ischemic heart failure) [9,10,20–22]. However, in the absence of high-quality comparative incidence data, such theories are difficult to evaluate. Beyond understanding the relative prevalence of these diseases in SSA, there is also a need for an understanding of their relative contribution to hospital admissions and healthcare utilization, a measure of disease burden of particular interest to public health officials, clinicians, and patients.

The purpose of this study was to compare the relative burden of stroke, ACS, and different etiologies of heart failure among admissions to a tertiary care center in northern Tanzania. Given existing historical data about stroke admissions at the same hospital [4], another aim of this study was to report temporal trends in stroke admissions.

Methods

This study was performed at Kilimanjaro Christian Medical Centre (KCMC), a tertiary care center in northern Tanzania. In 2014, the local prevalence of hypertension was 28% [23] and the prevalence of diabetes was 5.7% [24]. The emergency department (ED) receives all high-acuity patients who present to the hospital and require admission. The ED has access to computed tomography scanning, plain radiography, electrocardiography, echocardiography, and laboratory testing including troponin assays. ED physicians also have access to the patient's hospital chart including any prior diagnostic workup.

An ED patient logbook is maintained by nursing staff. The information recorded in this logbook includes patient demographics, vital signs, blood glucose, diagnosis, and disposition. Diagnoses are copied directly from the patient's chart. Admission diagnoses are free-texted by the admitting physician and are not standardized to ICD-10 taxonomy. In cases of heart failure, the underlying etiology of heart failure is recorded in the logbook if it is known to the physician based on existing diagnostic data. All adult (≥18 years) patient data from the logbook was entered retrospectively into an electronic database for a six-month period, from September 21st, 2017 to March 22nd, 2018. All adult admissions were included in the database; no cases were excluded. Data entry was performed by a physician who received specific training in the methods, design, and aims of the study. Data was entered exactly as recorded; no data abstraction or interpretation was performed during data entry. As such, we did not perform duplicate data entry with inter-rater agreement.

Cases of ACS were defined by a documented admission diagnosis of ACS, ST elevation myocardial infarction, non-ST elevation myocardial infarction, myocardial infarction, or unstable angina. Cases of heart failure were defined by a documented admission diagnosis of heart failure, congestive heart failure, or congestive cardiac failure. Cases of stroke were defined by an admission diagnosis of stroke, ischemic stroke, hemorrhagic stroke, or cerebrovascular accident. Hypertension was defined as a diagnosis of hypertension, or systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg. Diabetes was defined as a diagnosis of diabetes mellitus or random blood glucose ≥ 200 mg/dL, consistent with guidelines of the American Diabetes Association [25]. Primary admission diagnosis was defined as the first admission diagnosis listed for each admitted patient.

The number of annual stroke admissions at KCMC in 1974–1976, 1984–1986, 1994–1995, and 2008 has been previously published [4]. The annual number of stroke admissions for 2017–2018 was calculated by multiplying the observed number of cases by 1.995, corresponding to the fact that admission data was reviewed for 183 of 365 calendar days. To account for background population growth, the number of observed cases was adjusted by the population of the Moshi Urban District, where KCMC is located. Population figures were taken from Tanzanian National Census data from years 1967–2012 as well as the National Bureau of Statistics population projections for 2017 [26–28]. Linear trends in population between census years were assumed when censuses were not performed in the same year as stroke admission data. To our knowledge, there are no published data regarding heart failure or ACS admissions at KCMC across prior decades, so temporal trends in heart failure and ACS admissions were not investigated in the present study.

All data analysis was performed in RStudio (v 1.1.456, RStudio Inc, Boston, MA). Odds ratios were constructed from contingency tables. Associations between categorical variables were assessed using Pearson's chi-squared, except in cases where the expected cell count was <10, when Fisher's Exact method was used. Associations between continuous and categorical variables were assessed using the Welch two sample *t*-test.

This study received approval from the Duke Health Institutional Review Board, the Kilimanjaro Christian Medical Centre Research Ethics Committee, and the Tanzania National Institutes for Medical Research Ethics Coordinating Committee. As this was a retrospective observational study, the requirement for individual informed consent was waived. All study protocols conformed to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in approval from the relevant human research committees.

Results

During the study period, 3961 adult patients presented to the KCMC ED, of whom 2418 (62.1%) were admitted. The median (range) age of admitted adult patients was 52 (18, 105) years, and 1090 (45.1%) admitted patients were male.

Of admitted patients, 204 (8.4%) had a diagnosis of stroke, 9 (0.3%) had a diagnosis of ACS, and 294 (12.2%) had a diagnosis of heart failure. Together, these diagnoses accounted for 503 (20.8%) admissions. The ratio of ACS admissions to heart failure admissions and stroke admissions was 1:32.7 and 1:22.7, respectively.

Table 1 compares features of patients diagnosed with ACS, heart failure, and stroke to all other admitted patients. Patients with heart failure (mean age 62.4 years) and stroke (mean age 66.2 years) were significantly older than other admitted patients (mean age 49.6 years, $p < 0.001$). Hypertension was significantly more common among patients with ACS (OR 4.50, 95% CI 1.14-22.64, $p = 0.027$), patients with heart failure (OR 3.34, 95% CI 2.60–4.31, $p < 0.001$), and patients with stroke (OR 5.94, 95% CI 4.33–8.24, $p < 0.001$), than among other admitted patients. Diabetes was less common among patients with heart failure than among other admitted patients (OR 0.62, 95% CI 0.42–0.90, $p = 0.014$). There was no association between gender and diagnoses of ACS, heart failure, or stroke.

Three patients with an admission diagnosis of heart failure had primary admission diagnoses other than heart failure. No patient with stroke or ACS had alternate primary admission diagnoses. Table 2 presents the most common primary admission diagnoses of all adult admissions at KCMC. Heart failure and stroke were the most common

Table 1
Features of adult patients admitted with stroke, acute coronary syndrome, and heart failure compared to other admitted patients, northern Tanzania, September 2017–March 2018.

	Other admissions (N = 1915)	Stroke (N = 204)	OR (95% CI)[a]	*p*	ACS (N = 9)	OR (95% CI)[a]	*p*	Heart failure (N = 294)	OR (95% CI)[a]	*p*
Male, n(%)	870 (45.5%)	87 (42.6%)	0.89 (0.66, 1.19)	0.432	4 (44.4%)	0.96 (0.23, 3.79)	0.999	130 (44.2%)	0.95 (0.74, 1.21)	0.674
Age, mean (sd), years	49.6 (19.8)	66.2 (16.3)		<0.001*	51.4 (20.0)		0.794	62.4 (20.3)		<0.001*
Hypertension, n(%)	579 (30.2%)	147 (72.1%)	5.94 (4.33, 8.24)	<0.001*	6 (66.7%)	4.50 (1.14, 22.64)	0.027*	174 (59.2%)	3.34 (2.60,4.31)	<0.001*
Diabetes, n(%)	324 (16.9%)	29 (14.2%)	0.82 (0.53, 1.21)	0.325	2 (22.2%)	1.48 (0.20, 6.33)	0.654	33 (11.2%)	0.62 (0.42, 0.90)	0.014*

ACS: acute coronary syndrome.
[a] Relative to other admissions
* $p < 0.05$

Table 2
Ten most common primary admission diagnoses among adult admissions at a tertiary care center, northern Tanzania, 2017-2018 (N = 2418).

Primary admission diagnosis	n	%
Heart failure	291	12.0%
Stroke	204	8.4%
Gastrointestinal hemorrhage	162	6.7%
Uncontrolled hypertension	134	5.5%
Anemia	128	5.3%
Hyperglycemia/DKA	118	4.9%
Intestinal obstruction	77	3.2%
Renal failure/acute kidney injury	63	2.6%
Pneumonia	56	2.3%
Cellulitis	50	2.1%
Others	1135	46.9%

DKA: diabetic ketoacidosis.

Table 3
Etiologies of heart failure cited by clinicians among admitted patients with heart failure, northern Tanzania, September 2017–March 2018 (N = 294).

Heart failure etiology	n	%
Uncontrolled hypertension	124	42.2%
Cardiomyopathies	29	9.9%
Dilated cardiomyopathy	25	8.5%
Post-partum cardiomyopathy	3	1.0%
HIV cardiomyopathy	1	0.3%
Valvular etiologies	10	3.4%
Rheumatic heart disease	7	2.3%
Valvular heart disease	3	1.0%
Ischemic heart disease	1	0.3%
Unknown or unspecified	128	43.5%

primary admission diagnoses, accounting for 291 (12.0%) and 204 (8.4%) admissions, respectively.

Table 3 presents the etiologies of heart failure cited by clinicians for the 294 patients with admission diagnoses of heart failure. Uncontrolled hypertension was the most commonly identified cause of heart failure, cited in 124 (42.2%) cases. Only 1 (0.3%) case of heart failure was attributed to ischemic heart disease.

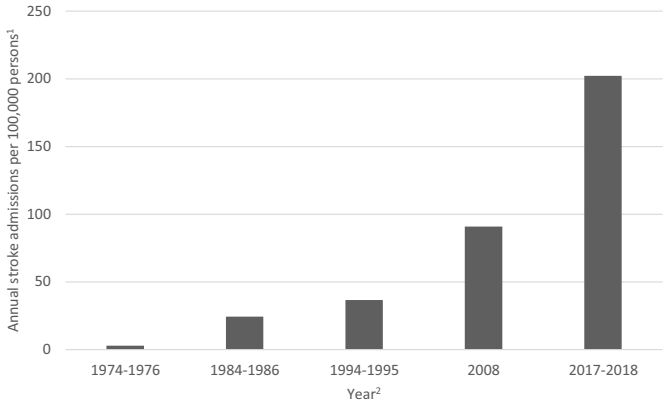

Fig. 1. Annual stroke admissions per 100,000 population at a single tertiary care center in Tanzania, 1974–2018.
[1]Adjusted by the total population of the Moshi Urban district in the given year.
[2]Data from 1974-2008 previously published[4].

Table 4 presents trends in stroke admissions at KCMC from 1974 to 2018. The estimated annual number of stroke admissions in 2017–2018 was 406.7, which represents a 313-fold increase from 1974–1976, when there were 1.3 annual admissions. The population-adjusted trend in annual stroke admissions is presented in Fig. 1. Adjusting for population growth, stroke admissions increased 70-fold, from 2.9 annual admissions per 100,000 population in 1974–1976 to 202.2 annual admissions per 100,000 in 2017–2018. The volume of stroke admissions in 2017–2018 was more than double that observed a decade earlier, when 90.9 annual admissions per 100,000 were reported.

Discussion

Heart failure and stroke were the most common admission diagnoses at a tertiary care center in northern Tanzania, accounting for more than one-fifth of all hospital admissions. ACS was an exceedingly rare admission diagnosis, and ischemic heart disease was rarely cited as

Table 4
Trends in stroke admissions at a single referral tertiary care center in northern Tanzania, 1974–2018.

Year	Annual stroke admissions	Stroke admissions per 100,000 population[a]	Annual number (%) male stroke admissions	Mean (sd) age of stroke patients, years
1974–1976[b]	1.3	2.9	1.3 (100)	52.3 (19.7)
1984–1986[b]	20.3	24.4	12.0 (59.0)	62.1 (15.8)
1994–1995[b]	43.5	36.6	26.0 (59.8)	62.5 (15.2)
2008[b]	153.0	90.9	77.0 (50.3)	67.9 (16.6)
2017–2018	406.7	202.2	173.6 (42.6)	66.2 (16.3)

[a] Adjusted by the total population of the Moshi Urban district in the given year.
[b] Data from 1974–2008 previously published [4].

a cause of heart failure. The large discrepancy between admissions for ACS versus other forms of cardiovascular disease raises important epidemiologic questions. Comparison with historical data further demonstrated a marked increase in the volume of stroke admissions, which, after controlling for population growth, rose 70-fold over period of four decades. These findings underscore the urgent need for public health interventions to combat cardiovascular disease in Tanzania.

Stroke accounted for nearly one in ten adult admissions in this study, similar to the proportion reported in Cameroon and Ghana [2,3]. The burden of stroke observed in our study was substantially more than what has been reported outside SSA: in the United States (US), for example, all acute cerebrovascular disease accounted for only 2.0% of adult hospitalizations in 2014 [29]. Moreover, the data presented here provides further evidence of the rapid increase in stroke burden in SSA, with a population-adjusted 70-fold increase in admissions over the past 43 years. These data suggest the stroke epidemic in Tanzania is growing particularly rapidly and warrants urgent attention from public health officials.

Heart failure was the leading cause of hospitalization in northern Tanzania, accounting for more than one in ten adult admissions. This is substantially higher than what has been observed outside SSA: heart failure accounted for 3.0% of adult admissions in the US in 2014 [29]. Even compared to other settings in SSA, the 12.2% of hospital admissions due to heart failure observed in our study is high: recent studies in Zimbabwe [30], Ghana [8], and Nigeria [31,32] reported that heart failure accounted for 4.7-9.6% of adult admissions. In northern Tanzania, this single diagnosis consumes substantial inpatient hospital resources, and public health interventions are needed to prevent costly hospitalizations. Although cost data was not collected in this study, previous studies in SSA have demonstrated that heart failure hospitalizations are catastrophically expensive for patients [33]. Uncontrolled hypertension was the most commonly identified etiology of heart failure while ischemic heart disease was rarely cited as a cause of heart failure in our study, consistent with the results of other studies across SSA [17,18]. This stands in stark contrast to Europe and North America, where the majority of heart failure is due to ischemic heart disease [19].

To date, little research has been done regarding the burden of ACS among hospital admissions in SSA. ACS was a very uncommon diagnosis in northern Tanzania, accounting for 0.3% of adult admissions. The paucity of ACS admissions in our study again stands in contrast to data from outside SSA: in the US, myocardial infarction accounted for 2.0% of adult hospitalizations in 2014 [29]. Moreover, the scarcity of ACS admissions relative to other cardiovascular admissions in northern Tanzania is particularly notable. The ratio of ACS admissions to heart failure admissions was approximately 1:33 in our study, however in the US, this ratio was 1:1.5 in 2014 [29]. Similarly, the ratio of ACS admissions to stroke admissions in our study was 1:23, whereas in the US in 2014 this ratio was 1:1.0 [29]. This disparity in ACS diagnoses versus other cardiovascular diagnoses does not appear to be unique to East Africa: a recent study in Ghana reported that the ratio of ischemic heart disease admissions to heart failure admissions was 1:12 [8].

The apparent difference in the distribution of cardiovascular disease phenotypes in SSA versus other world regions raises many pressing epidemiologic questions. Possible explanations for the disparity include widespread under-detection of ACS in SSA or a combination of unique environmental or genetic risk factors leading to a predilection for certain forms of cardiovascular disease. Some have postulated that ACS may be under-diagnosed in SSA due to poor community awareness and delayed healthcare seeking, inadequate physician training, and lack of diagnostic and treatment capacity [34]. Indeed, recent community surveys in Tanzania found that few adults knew the symptoms of ACS or would present to a hospital for such symptoms, whereas the large majority of adult Tanzanians would present to a hospital for stroke-like symptoms [35–37]. These results suggest that patient knowledge and behaviors may be driving ACS under-detection in hospital-based studies in SSA. Moreover, a recent qualitative study among Tanzanian providers found that physicians routinely failed to consider the diagnosis of ACS and did not feel comfortable ordering or interpreting diagnostic investigations for ACS such as electrocardiograms [38]. These findings suggest that misdiagnosis of ACS may be common in Tanzania, and therefore the apparent scarcity of ACS reported in studies like ours may not reflect the true burden of ACS in SSA. Alternatively, some have argued that hypertension is the dominant cardiovascular risk factor in SSA whereas atherosclerosis, hyperlipidemia, and smoking are relatively more common in the rest of the world, which may explain the different phenotypes of cardiovascular disease in SSA [21]. Others have raised the possibility of unique genetic or environmental factors that may predispose Africans to stroke and heart failure versus ACS [20,22]. Ultimately, a combination of these factors may explain the low burden of ACS relative to other forms of cardiovascular disease in Tanzania and SSA at large. However, the findings presented here emphasize the need for multiple avenues of research to understand patient care-seeking behavior, physician diagnostic practices, and the true burden of disease of ACS in SSA.

This study had several limitations. This study reported the clinical diagnoses according to the admitting physician, but the clinical and diagnostic data supporting these diagnoses were not reviewed and therefore no evaluation of the accuracy of these clinical diagnoses is possible. However, evidence from SSA suggests that clinical diagnoses of stroke have >80% positive predictive value for stroke [39,40]. Similarly, studies outside SSA have shown that clinical diagnoses of heart failure are generally accurate [41,42]. Little is known about the accuracy of clinical diagnoses of ACS in SSA, however. As described above, there is growing evidence that ACS may be commonly missed by emergency physicians in SSA [38]; this may have resulted in an underestimate of the burden of ACS among the patients in our study. With regards to longitudinal data comparisons, trends in stroke incidence over time may be related to improvement in diagnostic techniques as opposed to purely an increase in disease incidence. Furthermore, the admissions logbook which served as the data source for this study did not include information regarding type of stroke or treatments given; such data would have allowed for a more granular description of local stroke epidemiology and treatment practices.

Conclusions

Heart failure and stroke are the two most common admission diagnoses among adults in northern Tanzania and consume a large proportion of inpatient resources. The burden of stroke admissions is increasing rapidly, and preventative interventions are needed to reduce the growing burden of cardiovascular disease among hospital admissions. ACS is an extremely rare diagnosis in northern Tanzania relative to other forms of cardiovascular disease, and further research is needed to ascertain the reasons for this discrepancy.

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Author contributions

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: JTH contributed 35%, FMS contributed 25%, SWG contributed 20%, and ATL, BTM, LTA and JAB all contributed 5%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Dissemination of results

The results of this study were shared with staff members at Kilimanjaro Christian Medical Centre emergency department via informal presentation

Declaration of Competing Interest

The authors declare no conflict of interest.

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