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The prevalence, management, and thirty-day outcomes of symptomatic atrial fibrillation in a Tanzanian emergency department

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ABSTRACT

Introduction: Data describing atrial fibrillation (AF) care in emergency centres (ECs) in sub-Saharan Africa is lacking. We sought to describe the prevalence and outcomes of AF in a Tanzanian EC.

Methods: In a prospective, observational study, adults presenting with chest pain or shortness of breath to a Tanzanian EC were enrolled from January through October 2019. Participants underwent electrocardiogram testing which were reviewed by two independent physician judges to determine presence of AF. Participants were asked about their medical history and medication use at enrollment, and a follow-up questionnaire was administered via telephone thirty days later to assess mortality, interim stroke, and medication use.

Results: Of 681 enrolled patients, 53 (7.8%) had AF. The mean age of participants with AF was 68.1, with a standard deviation (sd) of 21.1 years, and 23 of the 53 (43.4%) being male. On presentation, none of the participants found to have AF reported a previous history of AF. The median CHADS-VASC score among participants was 4 with an interquartile range (IQR) of 2-4. No participants were taking an anticoagulant at baseline. On index presentation, 49 (92.5%) participants with AF were hospitalised with 52 (98.1%) participants completing 30-day follow-up. 18 (34%) participants died, and 5 (9.6%) suffered a stroke. Of the surviving 31 participants with AF and a CHADS-VASC score ≥ 2, none were taking other anti-coagulants at 30 days. Compared to participants without AF, participants with AF were more likely to be hospitalised (OR 5.25, 95% CI 2.10-17.95, $p < 0.001$), more likely to die within thirty days (OR 1.93, 95% CI 1.03-3.50, $p = 0.031$), and more likely to suffer a stroke within thirty days (OR 5.91, 95% CI 1.76-17.28, $p < 0.001$).

Discussion: AF is common in a Tanzanian EC, with thirty-day mortality being high, but use of evidence-based therapies is rare. There is an opportunity to improve AF care and outcomes in Tanzania.

African relevance

- There is a dearth of data describing atrial fibrillation care and outcomes in emergency centres in sub-Saharan Africa.
- This study found that in a Tanzanian emergency centre, atrial fibrillation was common but awareness was low, use of anti-coagulation was rare, and thirty-day mortality and stroke rates were high.
- These findings suggest that efforts may be needed to improve AF surveillance, care, and outcomes in emergency centres in sub-Saharan Africa.

Introduction

Atrial Fibrillation (AF) is the most common arrhythmia of clinical significance worldwide, and is linked to substantial morbidity and mortality [1,2]. In 2010 there were an estimated 33.5 million individuals living with AF globally, but there is only limited data

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describing the burden or outcomes of AF in sub-Saharan Africa (SSA) [3,4]. Valvular heart disease, in part due to a relatively high burden of rheumatic heart disease, is particularly common in SSA and is a major risk factor for AF in the region [4]. Apart from valvular heart disease, the ongoing increase in the prevalence of other AF risk factors such as hypertension, obesity, and advanced age [5], are expected to result in a growing burden of AF in SSA [6,7]. Indeed, a recent analysis of data from the Global Burden of Disease study found that the burden of AF was increasing more rapidly than any other cardiovascular disease in SSA [8]. To address this growing disease burden [9], further data regarding the epidemiology, care, and outcomes of AF in SSA are needed.

The management of AF in many parts of SSA is constrained by resource limitations [10,11]. The diagnosis of AF requires both access to electrocardiography (ECG) and expertise to interpret this diagnostic test which are not universal across SSA [12,13]. Moreover anticoagulation; the cornerstone of long-term AF management, requires therapies, laboratory monitoring, and routine outpatient follow-up that are not widely available in SSA settings [10]. The CHADS-VASC risk stratification tool is used worldwide to assess the need for anticoagulation [14], but existing evidence suggests that this tool is used inconsistently in SSA. [7] Recent reviews of the few existing studies of AF management in SSA found that even though the majority of participants in a heterogenous group of studies met criteria for anticoagulation, use of anticoagulants was woefully suboptimal [7,15]. A 2016 study of patients admitted for AF to a cardiology unit in Burkina Faso, for example, found that 98% of patients had CHADS-VASC scores greater than 1, but only 35% of patients were on anticoagulation [16]. The challenges many SSA health systems have in managing AF and preventing its complications are well-summarised by the McKinsey report on the Tanzanian healthcare system: limited access to primary care, a severely understaffed health workforce, and lack of funding for technological equipment such as ECGs [17,18]. In this context, cost of screening and long-term follow-up for AF for many patients in SSA is potentially prohibitive [6,7].

As the burden of cardiovascular disease increases in SSA, the need for acute care also increases [19]. In many parts of SSA, individuals tend to seek healthcare sporadically when they are symptomatic, in urgent care settings such as the emergency centre (EC); some patients seldom seek care in primary care settings [17,18,20]. This is especially true for AF which is often asymptomatic [21,22]. Since ECs are often equipped with cardiac monitoring capabilities necessary to diagnose AF [23], the EC may be an optimal setting to diagnose and initiate treatment for AF [24]. However, to our knowledge, there are no existing studies on AF prevalence, management, and outcomes in ECs in SSA [7]..

This prospective observational study aims to describe the prevalence, management, and outcomes of AF among adults presenting with cardiac symptoms to an EC in northern Tanzania.

Methods

This study was conducted in the EC at Kilimanjaro Christian Medical Centre (KCMC). KCMC is a tertiary referral center situated in northern Tanzania, where the community prevalence of hypertension among adults is approximately 28% [25]. The KCMC EC sees approximately 30,000 patients per year, and has access to 12-lead ECG and standard laboratory testing including coagulation studies.

This was a prospective observational study, conducted from January 2019 through October 2019. The participants in this study came from a prospective screening study for acute myocardial infarction, with detailed methods previously published [26]. Briefly, trained research assistants screened patients presenting to the KCMC EC, Monday through Friday, from 8 AM until 11 PM. Any adult (>17 years of age) presenting with symptoms of chest pain or shortness of breath were eligible for enrollment. Patients with self-reported fever or chest pain secondary to trauma were excluded.

Enrolled participants completed a standardised questionnaire about medical history, medication use, and demographics. Trained research assistants obtained a 12-lead ECG with six-second, one-lead rhythm strip at time of enrollment, and measured participant weight, height, and blood pressure. ECGs were shared with the EC clinical team immediately. While in the EC, treatments and dispositions were directly observed and recorded. If a creatinine was obtained by the EC clinical team, the participant's serum creatinine level was collected directly from their chart. Physician-documented diagnoses were copied directly from the electronic medical record. Thirty days after enrollment, participants were contacted via telephone for a follow-up questionnaire; the follow-up questionnaire assessed mortality, medication use, rehospitalisation, and any interim strokes. If participants were not reachable by telephone, research assistants conducted in-home visits to administer the follow-up questionnaire. In cases of participant death, a relative was asked to complete the questionnaire.

Presence of AF was defined by EC ECG result, according to European Society of Cardiology guidelines; specifically AF was defined as a supraventricular arrhythmia with irregularly, irregular R-R intervals, absent P-waves, and irregular atrial activity [27]. All ECGs were interpreted by two independent physician adjudicators, with training in either emergency medicine or cardiology. Physician adjudicators reviewed ECGs to determine the presence of atrial fibrillation; in cases of disagreement, a third physician adjudicator served as the tiebreaker. Physician adjudicators were blinded to all clinical information other than participant age and sex. Agreement among physician adjudicators regarding the presence of AF was excellent (99% agreement, $\kappa = 0.935$). Participant co-morbidities such as hypertension, diabetes, and prior diagnosis of AF were defined by either participant self-report or by documentation as past medical history in the electronic medical record. Chronic kidney disease was defined by either participant self-report or estimated glomerular filtration rate < 30 mL/min. Participant medication use, both prior to EC presentation and at thirty-day follow-up, was also defined by participant self-report. History of ischemic heart disease was defined by any of the following: self-reported history of myocardial infarction, presence of pathologic Q waves in contiguous ECG leads consistent with prior infarction as per Fourth Universal Definition of Myocardial Infarction criteria [28], pathologic ST elevation in contiguous leads as per universal criteria for acute myocardial infarction, or serum troponin >99th percentile of the manufacturer-defined normal range. Sedentary lifestyle was defined as a self-reported less than 150 min of moderately vigorous exercise per week, as per World Health Organization guidelines [29]. Principal EC diagnosis was defined as the first diagnosis documented by the EC physician in the patient's electronic medical record. Occurrence of stroke in the thirty days following EC presentation was defined by participant self-report.

Statistical analysis was performed in the R suite. Continuous variables are presented as medians with interquartile range (IQR) and categorical variables are presented as frequencies. Participants who were lost to follow-up were excluded from follow-up analyses. Estimated glomerular filtration rate was calculated directly from the documented serum creatinine level using the CKD-EPI equation. [30] Mean arterial pressure was calculated adding two-thirds of the measured diastolic blood pressure to one-third of the measured systolic blood pressure. Each participant's CHADS-VASC score was calculated directly from their self-reported comorbidities [31]. To compare characteristics of participants with and without AF, Welch's *t*-test was used for continuous variables and Pearson's chi-squared was used for categorical variables. In cases where the expected cell count was <5, Fisher's exact test was used for comparisons of categorical variables. Odds ratios and corresponding 95% confidence intervals were calculated directly from two-by-two contingency tables.

All participants provided written, informed consent at the time of enrollment. The study protocol was approved by ethical review committees at KCMC, the Tanzania National Institute for Medical Research, and Duke Health.

Results

Of 681 enrolled participants presenting to KCMC EC with shortness of breath or chest pain, 53 (7.8%) of patients were found to be in AF. Table 1 presents the characteristics of participants with AF and compares them to participants without AF. The mean age and standard deviation (sd) of participants with AF was 68.1 (sd = 21.1) years, with 23 of the 53 patients (43.4%) being male. Common comorbidities among participants with AF included hypertension (n = 39, 73.6%), heart failure (n = 32, 60.4%), and ischemic heart disease (n = 26, 49.1%). The most common presenting symptom among participants with AF was shortness of breath (n = 50, 94.4%). None of the participants with AF reported a known prior history of AF, and their median CHADS-VASC score was 4 (IQR = 2,4). At the time of initial EC presentation, 4 (7.6%) participants with AF were on aspirin therapy, and no participants were taking any other anticoagulant such as warfarin. On presentation, 21 (39.6%) participants with AF had rapid ventricular rate (pulse >100 beats per minute). Relative to participants without AF, participants with AF were more likely to be older (mean age 68.1 years versus 58.9 years, $p = 0.03$), more likely to have a known history of hypertension (OR 1.85, 95% CI 1.01–3.61, $p = 0.49$), more likely to have a known history of heart failure (OR 3.37, 95% CI 1.19–6.09, $p < 0.001$), and were more likely to report a sedentary lifestyle (OR 3.35, 95% CI 1.63–7.85, $p = 0.001$).

Table 2 summarises the management of patients with AF in the EC. While in the EC, 3 (5.7%) patients received aspirin, and 3 (5.7%) patients received a beta-blocker. No patient received heparin or a calcium channel blocker. The vast majority of patients with AF (49 patients, 92.5%) were admitted to the hospital. Compared to participants without AF, AF participants were more likely to be treated with a beta-blocker (OR 5.44, 95% CI 1.08–20.82, $p = 0.036$), and were more likely to be admitted to the hospital (OR 5.25, 95% CI 2.10–17.95, $p < 0.001$).

Thirty-day follow-up was achieved for 52 of 53 (98.1%) participants with AF, and 617 of 628 (98.2%) of participants without AF. Of participants with AF, 18 (34.6%) died within 30 days of hospital presentation, and 5 (9.6%) suffered a stroke (Table 3). Compared to participants without AF, participants with AF were more likely to die (OR 1.93, 95% CI 1.03–3.50, $p = 0.031$) and more likely to suffer a stroke (OR 5.91, 95% CI 1.76–17.28, $p < 0.001$). Of the 34 participants with AF surviving to thirty days, 3 (8.8%) participants were re-hospitalised within 30 days, 1 (1.9%) was taking aspirin at 30 days, and none were taking another anti-coagulant (Table 4). Fig. 1 summarises the CHADS-VASC scores and anticoagulant use of participants at 30-day follow-up. Of the surviving 31 participants with AF and a CHADS-VASC score ≥ 2, 1 (3.2%) was taking aspirin, and none were taking other anti-coagulants.

Discussion

To our knowledge, this study is one of the first prospective studies of AF among EC patients in SSA. We found that AF was relatively common in the EC setting, but patient awareness of AF was low and thirty-day outcomes following EC presentation were poor. Approximately one-third of patients with AF died within 30 days of hospital presentation, and few surviving patients were using evidence-based therapies such as anticoagulation. No patients at high risk for stroke (CHADS-VASC ≥2) were taking an anticoagulant, either before or after their EC presentation. We also found that, compared to other EC patients presenting with chest pain or shortness of breath, patients with AF were more likely to be admitted to the hospital, more likely to die within thirty days of presentation, and more likely to suffer a stroke within thirty days. This data highlights the need both for further study of AF epidemiology and interventions to improve AF care across SSA.

AF was found in 7.8% of EC patients presenting with shortness of breath or chest pain. This is higher than what has been described in high-income settings: in the US, for example, approximately 5.7% of adults

Table 1
Characteristics of adults presenting to the KCMC EC with and without atrial fibrillation, 2019 (n = 681).

	Patients with AF, n (%) N = 53	Patients without AF, n(%) N = 628	OR (95% CI)	p
Characteristic	n (%)	N (%)		
Age, mean (sd) years	68.1 (21.1)	58.9 (19.4)		0.003*
Male	23 (43.4%)	294 (46.8%)	0.87 (0.49–1.53)	0.632
BMI, mean (sd), kg/m2	23.5 (5.9)	25.2 (5.5)		0.126
Self-reported history of atrial fibrillation	0 (0%)	0 (0%)	–	–
Known co-morbidities				
Hypertension	39 (73.6%)	376 (59.9%)	1.85 (1.01–3.61)	0.049*
Heart failure	32 (60.4%)	196 (31.2%)	3.37 (1.91–6.09)	<0.001*
Ischemic heart disease	16 (30.2%)	221 (35.2%)	0.80 (0.42–1.45)	0.463
Chronic kidney disease	10 (18.9%)	72 (11.5%)	1.81 (0.82–3.65)	0.112
Diabetes	5 (9.4%)	145 (23.1%)	0.36 (0.12–0.84)	0.021*
History of stroke	4 (7.5%)	24 (3.8%)	2.11 (0.59–5.79)	0.265
Hyperlipidemia	2 (3.8%)	45 (7.2%)	0.54 (0.08–1.84)	0.570
Valvular heart disease	1 (1.9%)	16 (2.5%)	0.83 (0.03–4.22)	0.861
HIV	1 (1.9%)	15 (2.3%)	0.89 (0.04–4.54)	0.912
History of alcohol use	39 (73.6%)	432 (68.8%)	1.25 (0.68–2.45)	0.468
History of tobacco use	16 (30.2%)	195 (31.1%)	0.97 (0.51–1.75)	0.896
Sedentary lifestyle	45 (84.9%)	391 (62.3%)	3.35 (1.63–7.85)	0.001*
Medication use at baseline				
Antihypertensive	16 (30.2%)	147 (23.4%)	1.58 (0.64–4.30)	0.314
Beta-Blocker	3 (5.7%)	27 (4.3%)	1.39 (0.31–4.16)	0.643
Calcium channel blocker	2 (3.8%)	40 (6.4%)	0.62 (0.09–2.10)	0.451
Other	13 (24.5%)	120 (19.1%)	1.39 (0.69–2.61)	0.339
Antiplatelet	4 (7.5%)	50 (8%)	1.13 (0.29–3.72)	0.866
Warfarin	0 (0%)	3 (0.5%)	–	–
Other anticoagulant	0 (0%)	0 (0%)	–	–
Presenting symptoms				
Shortness of breath	50 (94.4%)			
Chest pain	37 (69.9%)			
Leg swelling	29 (54.7%)			
Palpitations	16 (30.2%)			
Light-headedness/ syncope	3 (5.7%)			
Duration of symptoms prior to presentation, mean (sd), days	7.2 (12.6)			
Pulse, mean (sd), beats per minute	91.8 (27.0)			
Rapid ventricular rate at presentation (pulse > 100 beats per minute)	21 (39.6%)			
CHADS-VASC score, median (IQR)	4 (2, 4)			

AF: Atrial fibrillation.
* $p < 0.05$.

Table 2
Emergency centre management of adult patients presenting with atrial fibrillation, KCMC, 2019 (n = 681).

	Participants with AF, n (%) N = 53	Participants without AF, n (%) N = 628	OR (95% CI)	*p*
	n (%)	(%)		
Medications administered				
Aspirin	3 (5.7%)	47 (7.5%)	0.77 (0.18–2.23)	0.625
Heparin	0 (0%)	6 (1.0%)	–	
Beta-blocker	3 (5.75%)	7 (1.1%)	5.44 (1.08–20.82)	0.036*
Calcium channel blocker	0 (0%)	35 (5.6%)	–	–
Digoxin	2 (3.8%)	0	–	
Principal diagnosis				
Heart failure	21 (39.6%)	108 (17.2%)	–	
Symptomatic hypertension	13 (24.5%)	177 (28.2%)		
Atrial fibrillation	7 (13.2%)	0 (0%)		
Other	12 (22.6%)	343 (54.6%)		
Diagnosis of atrial fibrillation documented by EC physician	8 (15.1%)	0	–	
Admitted to hospital	49 (92.5%)	434 (69.1%)	5.25 (2.10–17.95)	<0.001*

AF: atrial fibrillation, EC = Emergency centre.

Table 3
Thirty-day outcomes following emergency centre presentation among patients with and without atrial fibrillation, northern Tanzania (n = 669)[a].

	Participants with AF, n(%) N = 52	Participants without AF, n(%) N = 617	OR (95% CI)	*p*
Death	18 (34.6%)	133 (21.6%)	1.93 (1.03–3.50)	0.031*
Suffered a stroke	5 (9.6%)	11 (1.8%)	5.91 (1.76–17.28)	<0.001*

[a] Excludes twelve patients lost to follow-up
AF: atrial fibrillation.

Table 4
Outcomes among patients with atrial fibrillation surviving to thirty days following emergency centre presentation (N = 34).

Surviving participants	n	(%)
Re-hospitalised	3	8.8%
Taking anti-platelet	1	2.9%
Taking anti-coagulant	0	0%
Taking beta blocker	0	0%
Taking calcium channel blocker	0	0%
Had 30-day follow-up appointment	7	20.5%

undergoing ECG testing in the EC were found to have AF [32]. Moreover, our observed prevalence of AF in the EC is higher than what has been reported in community-based screenings of asymptomatic adults in SSA, where population prevalence has generally been found to be less than 1% [33,34]. In the KCMC EC, the high burden of AF is coupled with low patient awareness. None of the participants with AF reported a known prior history of AF, and many had elevated heart rates on presentation. Furthermore, very few AF patients in our study reported taking guideline-recommended therapies prior to their EC visit; none reported taking an anticoagulant at baseline. These findings are in contrast to high-income settings like the United States, where the large majority of EC patients with AF are already aware of their AF and are taking appropriate anticoagulation [35]. The high prevalence of AF in our study, together with low patient awareness and low uptake of evidence-based therapies, suggests that the EC may be an ideal location to screen for AF, initiate medication therapies, arrange follow-ups, and educate patients. Although our study focused on AF care, additional observational studies are needed to identify opportunities to improve evidence-based care for other diseases that may be sub-optimally managed in ECs in SSA.

Thirty-day AF outcomes in our study were poor, with an all-cause mortality rate of 35%, which was significantly higher than among EC patients without AF. Furthermore, there was very low uptake of evidence-based anticoagulation following the EC visit, even among patients at high risk for stroke. The short-term mortality rates we observed in Tanzania are much higher than what has been reported in Kenya [4], and are also much higher than what has been reported outside of SSA: recent studies from the United States, Canada, and Europe reported thirty-day mortality rates between 0 and 15% [36–40]. The higher mortality rate in Tanzania may be attributable to multiple factors, including low uptake of guideline-recommended therapies like anticoagulants and antihypertensives before and after the EC visit, limited access to primary care and specialists, and high short-term stroke rate. Indeed, the 30-day stroke rate observed in our cohort (10%) is much higher than what has been reported in high-income settings like Canada, where 0–5% of adults presenting to the EC with AF suffer a stroke within 30 days [36,39,40]. Combined with the low use of evidence-based therapies following the EC visit, only 20% of participants received a thirty-day follow-up appointment and 8.8% of participants were re-hospitalised within a month following their EC visit. Further study is urgently needed to describe barriers to high-quality AF care in Tanzania and to develop interventions to improve EC-based care in Tanzania and across SSA. Although not currently widely available in SSA, novel anticoagulants such as apixaban may eliminate some barriers to AF care in the region, since these agents do not require frequent laboratory monitoring or dose adjustments.

This study had several limitations. First, the study only included patients with chest pain or shortness of breath, excluding patients with other AF presentations. AF may present with a wide range of symptoms or be asymptomatic, so our approach likely under-estimated the burden of AF in our study setting. Secondly, we used a single 12-lead ECG to screen for AF, which likely excluded some patients with paroxysmal AF who were in sinus rhythm at time of enrollment, thus resulting in an underestimation of the true prevalence of AF. Thirdly, we relied on patients to self-report a prior history of AF, their medication use, and subsequent occurrence of stroke which may have led to an underestimation of usage rates of certain therapies and either over- or underestimation of subsequent stroke. Finally, we did not monitor inpatient care or the hospital discharge process, so it is unclear how prominent of a causative role AF played in the patients' current symptoms and inpatient hospital course. Furthermore, we are unable to determine whether the low usage rates of evidence-based therapies following the EC visit were due to clinician failure to prescribe such therapies, patient non-adherence, or a combination of both.

In conclusion, AF is common among patients in a Tanzanian EC, but patient awareness of AF is very low. Patients with AF experience high thirty-day mortality and stroke rate, and anti-coagulant therapy among such patients was rare both before and after their EC visit. The EC may be an important setting for AF screening, and interventions are needed to improve AF care in Tanzania.

Dissemination of results

Results of this study were shared with staff members at the data collection site through an informal presentation.

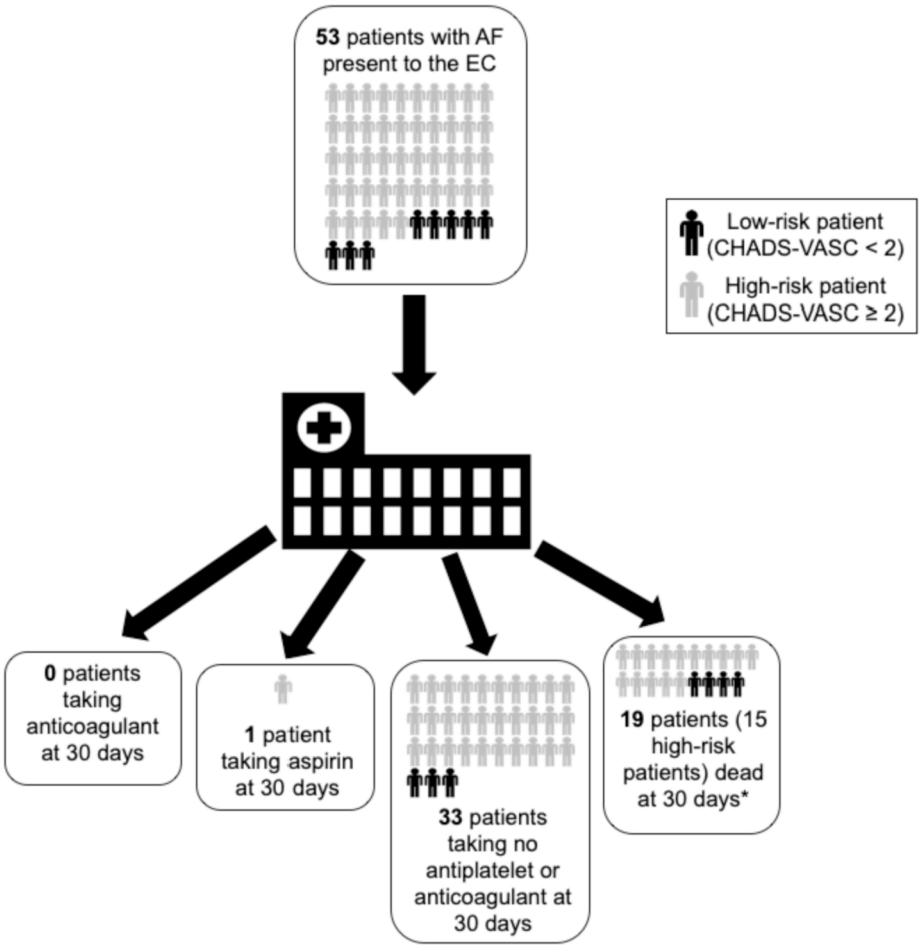

Fig. 1. Thirty day outcomes among patients with atrial fibrillation (AF) presenting to an emergency Centre (EC) in northern Tanzania (2019).
*Medication use among deceased participants at time of death was unknown.

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Authorship contribution statement

Authors contributed as following 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: IOO contributed 20%; JTH 20%; SP, FMS, TGT, and GLK 10% each; and TP, ZL, ATL, and GSB contributed 5% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

ATL and JTH's institution received grant funding from Abbott Laboratories and Roche Diagnostics for studies in which they were investigators; all other authors have no competing interests to declare.

References

[1] Wang Thomas J, Larson Martin G, Daniel Levy, Vasan Ramachandran S, Leip Eric P, Wolf Philip A, et al. Temporal relations of atrial fibrillation and congestive heart failure and their joint influence on mortality. Circulation 2003 Jun 17;107(23):2920–5.
2. Kannel WB, Wolf PA, Benjamin EJ, Levy D. Prevalence, incidence, prognosis, and predisposing conditions for atrial fibrillation: population-based estimates 1. Am J Cardiol 1998;82(7):2N–9N. Oct 16.
[3] Chugh SS, Havmoeller R, Narayanan K, Singh D, Rienstra M, Benjamin EJ, et al. Worldwide epidemiology of atrial fibrillation: a global burden of disease 2010 study. Circulation 2014;129(8):837–47. Feb 25.
4. Temu TM, Lane KA, Shen C, Ng'ang'a L, Akwanalo CO, Chen P-S. Clinical characteristics and 12-month outcomes of patients with valvular and non-valvular atrial fibrillation in Kenya. PLoS One 2017;12(9):e0185204.
[5] Kofi Amegah A. Tackling the growing burden of cardiovascular diseases in Sub-Saharan Africa. Circulation 2018;138(22):2449–51. Nov 27.
[6] Stambler BS, Ngunga LM. Atrial fibrillation in Sub-Saharan Africa: epidemiology, unmet needs, and treatment options. Int J Gen Med 2015;8:231–42.
[7] Noubiap JJ, Nyaga UF. A review of the epidemiology of atrial fibrillation in Sub-Saharan Africa. J Cardiovasc Electrophysiol 2019;30(12):3006–16. Dec.
[8] Moran A, Forouzanfar M, Sampson U, Chugh S, Feigin V, Mensah G. The epidemiology of cardiovascular diseases in sub-saharan Africa: the global burden of diseases, injuries and risk factors 2010 study. Prog Cardiovasc Dis 2013;56(3):234–9. Dec.
[9] Chugh SS, Blackshear JL, Shen WK, Hammill SC, Gersh BJ. Epidemiology and natural history of atrial fibrillation: clinical implications. J Am Coll Cardiol 2001 Feb;37(2):371–8.
10. Amin A, Houmsse A, Ishola A, Tyler J, Houmsse M. The current approach of atrial fibrillation management. Avicenna J Med 2016;6(1):8–16.
[11] Anakwue R, Ocheni S, Madu A. Utilization of Oral anticoagulation in a teaching Hospital in Nigeria. Ann Med Health Sci Res 2014;4(Suppl 3):S286–90.
[12] Gallagher J, McDonald K, Ledwidge M, Watson CJ. Heart failure in sub-saharan Africa. Card Fail Rev 2018;4(1):21–4. May.

[13] Hertz JT, Kweka GL, Manavalan P, Watt MH, Sakita FM. Provider-perceived barriers to diagnosis and treatment of acute coronary syndrome in Tanzania: a qualitative study. Int Health 2020;12(2):148–54. Feb 12.
[14] Coppens M, Eikelboom JW, Hart RG, Yusuf S, Lip GYH, Dorian P, et al. The CHA2DS2-VASc score identifies those patients with atrial fibrillation and a CHADS2 score of 1 who are unlikely to benefit from oral anticoagulant therapy. Eur Heart J 2013;34(3):170–6. Jan.
15. Worldwide oral anticoagulant prescription prevalence and trends in patients with atrial fibrillation from a multi-national cohort: insights from the International Collaborative Partnership for the Study of Atrial Fibrillation (INTERAF) Collaborative|Journal of the American College of Cardiology [Internet]. Available from: https://www.jacc.org/doi/full/10.1016/S0735-1097%2819%2930984-2; 2021.
16. Yameogo AR, Kologo JK, Mandi G, Kabore HP, Millogo GRC, Seghda AAT, et al. Use of vitamins K antagonists in non-valvular atrial fibrillation thromboembolic risk prevention in Burkina Faso. Pan Afr Med J 2016;24:108.
17. Strengthening sub-Saharan Africa's health systems: a practical approach [Internet]. Dec 14 Available from: https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/strengthening-sub-saharan-africas-health-systems-a-practical-approach#; 2020.
18. Mash R, Howe A, Olayemi O, Makwero M, Ray S, Zerihun M, et al. Reflections on family medicine and primary healthcare in Sub-Saharan Africa. BMJ Glob Health 2018;3(Suppl 3):e000662. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5950631/.
[19] Calvello E, Reynolds T, Hirshon JM, Buckle C, Moresky R, O'Neill J, et al. Emergency care in Sub-Saharan Africa: results of a consensus conference. Afr J Emerg Med 2013;3(1):42–8. Mar 1.
20. Galson SW, Stanifer JW, Hertz JT, Temu G, Thielman N, Gafaar T, et al. The burden of hypertension in the emergency department and linkage to care: a prospective cohort study in Tanzania. PLoS One 2019;14(1):e0211287.
[21] Dilaveris PE, Kennedy HL. Silent atrial fibrillation: epidemiology, diagnosis, and clinical impact. Clin Cardiol 2017;40(6):413–8. Jun.
22. Boriani G, Laroche C, Diemberger I, Fantecchi E, Popescu MI, Rasmussen LH, et al. Asymptomatic atrial fibrillation: clinical correlates, management, and outcomes in the EORP-AF pilot general registry. Am J Med 2015;128(5):509–18. e2.
[23] Zègre-Hemsey JK, Garvey JL, Carey MG. Cardiac monitoring in the emergency department. Crit Care Nurs Clin North Am 2016;28(3):331–45. Sep.
[24] Atzema CL, Barrett TW. Managing atrial fibrillation. Ann Emerg Med 2015;65(5):532–9. May.
25. Galson SW, Staton CA, Karia F, Kilonzo K, Lunyera J, Patel UD, et al. Epidemiology of hypertension in northern Tanzania: a community-based mixed-methods study. BMJ Open 2017;7(11):e018829. Nov 9.
[26] Hertz JT, Sakita FM, Kweka GL, Limkakeng AT, Galson SW, Ye JJ, et al. Acute myocardial infarction under-diagnosis and mortality in a tanzanian emergency department: a prospective observational study. Am Heart J 2020;226:214–21. Aug.
27. 2020 ESC. Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS) | European Heart Journal | Oxford Academic [Internet]. Available from: https://academic.oup.com/eurheartj/article/42/5/373/5899003#229346839; 2021.
[28] Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Fourth universal definition of myocardial infarction (2018). Glob Heart 2018;13(4):305–38. Dec.
29. WHO. Global recommendations on physical activity for health [Internet]. Geneva: World Health Organization. Available from: https://www.who.int/publications/i/item/9789241599979; 2021.
[30] Levey AS, Stevens LA, Schmid CH, Zhang Y, Castro AF, Feldman HI, et al. A new equation to estimate glomerular filtration rate. Ann Intern Med 2009;150(9):604–12. May 5.
[31] Lip GYH, Nieuwlaat R, Pisters R, Lane DA, Crijns HJGM. Refining clinical risk stratification for predicting stroke and thromboembolism in atrial fibrillation using a novel risk factor-based approach: the euro heart survey on atrial fibrillation. Chest 2010;137(2):263–72. Feb.
[32] Scott PA, Pancioli AM, Davis LA, Frederiksen SM, Eckman J. Prevalence of atrial fibrillation and antithrombotic prophylaxis in emergency department patients. Stroke 2002;33(11):2664–9. Nov.
33. Koopman JJE, van Bodegom D, Westendorp RGJ, Jukema JW. Scarcity of atrial fibrillation in a traditional African population: a community-based study. BMC Cardiovasc Disord 2014;18(14):87. Jul.
[34] Dewhurst MJ, Adams PC, Gray WK, Dewhurst F, Orega GP, Chaote P, et al. Strikingly low prevalence of atrial fibrillation in elderly Tanzanians. J Am Geriatr Soc 2012;60(6):1135–40. Jun.
[35] Fundarò C, Galli A, Paglia S, Colombo S, Rovellini A, Colombo L, et al. Atrial fibrillation in emergency department: prevalence of sinus rhythm 1 week after discharge. Emerg Med J EMJ. 2012;29(4):284–6. Apr.
36. Atzema CL, Austin PC, Miller E, Chong AS, Yun L, Dorian P. A population-based description of atrial fibrillation in the emergency department, 2002 to 2010. Ann Emerg Med 2013;62(6):570–7. e7.
[37] Sankaranarayanan R, Kirkwood G, Visweswariah R, Fox DJ. How does chronic atrial fibrillation influence mortality in the modern treatment era? Curr Cardiol Rev 2015 Aug;11(3):190–8.
38. Agbor VN, Aminde LN, Tianyi F-L, Mbanga CM, Petnga S-JN, Ditah C, et al. Atrial fibrillation among adults with heart failure in sub-Saharan Africa — prevalence, incidence and all-cause mortality: a systematic review and meta-analysis protocol. BMJ Open 2019;9(2):e022320. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6410087/.
39. Stiell IG, Clement CM, Rowe BH, Brison RJ, Wyse DG, Birnie D, et al. Outcomes for emergency department patients with recent-onset atrial fibrillation and flutter treated in Canadian hospitals. Ann Emerg Med 2017;69(5):562–71. e2.
[40] Yeo CFC, Li H, Koh ZX, Liu N, Ong MEH. Risk stratification of patients with atrial fibrillation in the emergency department. Am J Emerg Med 2020;38(9):1807–15. Sep.