Markers of Atherosclerosis, Clinical Characteristics, and Treatment Patterns in Heart Failure

A Case-Control Study of Middle-Aged Adult Heart Failure Patients in Rural Kenya

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Background: Although risk factors for heart failure are increasingly common worldwide, the contribution of atherosclerosis to heart failure in sub-Saharan Africa is largely unknown.

Objective: This study assessed the association between atherosclerotic risk factors and heart failure in a developing country.

Methods: We performed a case-control study of heart failure in rural Kenya. We assessed the risk factors for heart failure by using international criteria based on electrocardiogram (ECG), echocardiogram, physical examination findings, and laboratory testing. Atherosclerotic risk factors were determined by ECG, echocardiogram, ankle-brachial index (ABI), and lipid testing. We described the relationship of wall motion abnormalities on echocardiogram, ABI <0.9, and ischemic pattern on ECG with the presence of heart failure with multivariable logistic regression adjusting for age and sex and using adjusted odds ratios (AORs) and 95% confidence intervals (CIs).

Results: There were 125 cases and 191 controls (n = 316); 49% were male. The mean age was 60 (SD = 13) years. Most patients had hypertension (53%), and 16% had human immunodeficiency virus infection. Lipids were in the normal range for all. Cases were older than controls (62 years vs. 58 years, respectively). The most common abnormality associated with heart failure was dilated cardiomyopathy. Ischemic heart failure was the second most common cause in men. Cases were more likely to have an ABI <0.9 (46% vs. 31%; AOR: 1.99; 95% CI: 1.19 to 3.32), ischemia or infarct on ECG (68% vs. 43%; AOR: 3.01; 95% CI: 1.43 to 6.34), and wall motion abnormalities on echocardiogram (54% vs. 15%; AOR: 7.00; 95% CI: 3.95 to 12.39).

Conclusions: Ischemic heart failure is more common in Kenya than previously recognized. Noninvasive markers of atherosclerosis are routinely found among patients with heart failure. Treatment and prevention of heart failure in sub-Saharan Africa must consider many causes including those related to atherosclerosis.

In 2010, more than 41 million people had heart failure (HF) worldwide, a 14% increase from 1990 [1]. In the United States, there are more than 3 million physician visits and 1 million hospital discharges yearly for HF [2]. Readmission rates after hospitalization for HF are >50% 6 months after discharge, and 5-year mortality rates are 40% to 65% in the United States and Europe [3−5]. The economic impacts of HF in the United States are astonishing, with costs in 2010 topping $39.2 billion [6]. Corresponding data from sub-Saharan Africa (SSA) are not available because of challenges in disease classification [7] and a lack of population-based studies [8].

Coronary atherosclerosis is the most common cause of HF in high-income settings [9]. However, ischemic heart disease (IHD) and atherosclerosis have historically accounted for <2% of the burden of HF in SSA [10]. Much of the research showing a low prevalence of IHD in SSA, however, relied on a patient's report or electrocardiogram (ECG) alone [11,12]. Atherosclerotic cardiovascular diseases are becoming more common among patients in SSA with HF, according to some studies using contemporary diagnostic techniques in SSA [13,14], but not all [15,16]. Epidemiological and clinical data about the causes of HF from most countries in SSA remain unavailable, in part because of the generally low cardiovascular research productivity from the region [10,17].

To address this unmet need, we designed this study to 1) assess the major abnormalities associated with HF by using clinical, laboratory, and echocardiographic parameters; 2) describe treatment patterns for HF; and 3) assess the association between atherosclerotic risk factors and HF in western Kenya. Kenya (population 43.2 million in 2012)

is a middle-income country that is marked by a double burden of communicable and noncommunicable diseases [18] and is underrepresented in publications from SSA on HF epidemiology [8]. Findings from an economically developing country in the midst of an epidemiological transition may have local and worldwide relevance for similarly situated countries.

METHODS

Study design

We performed a case-control study to identify associations of markers of atherosclerosis with HF at a national referral hospital in western Kenya. Our methodological approach has 3 main components:

1. A description of the primary probable etiology of HF adjudicated using clinical, physical examination, and radiographic criteria according to society guidelines.
2. A determination of the distribution of risk factors (both atherosclerotic and nonatherosclerotic) for HF in cases and controls.
3. Regression modeling to determine the extent to which atherosclerotic risk factors were associated with higher or lower odds of having HF.

Setting

One of the 11 U.S. National Heart, Lung and Blood Institute Centers of Excellence [19] is in western Kenya, where Moi University School of Medicine has a 22-year relationship with a consortium of U.S. medical schools. This collaboration, the Academic Model Providing Access to Healthcare (AMPATH) [20,21], partners with Moi Teaching and Referral Hospital (Kenya's second national referral hospital, with 750 beds, and serving a catchment area of 13 million people [Fig. 1]) and Moi University School of Medicine. This study was conducted at Moi Teaching and Referral Hospital between June 2010 and December 2012 in the city of Eldoret, Kenya.

Participants

All patients ≥40 years old who were being seen in the inpatient wards, medical outpatient clinic, and cardiology outpatient clinics were eligible for enrollment. Cases constituted patients with a known or presumed diagnosis of HF on the basis of on a modified version of the Framingham HF criteria that uses clinical, physical examination, and radiographic parameters [22]. Controls constituted patients from the same clinical areas who had shortness of breath but no known HF. Symptomatic controls were selected to achieve similarities in location of enrollment, health care seeking behavior, and acuity of illness between groups. Patients were enrolled consecutively and were not matched. Patients were excluded if they were human immunodeficiency virus (HIV) seropositive with a CD4 count level ever <100 cells/ml, if they were within 6 months post-partum, if they were within 3 months of major trauma, or if they were known to have a history of malignant disease.

Variables

Enrollment and data collection. The following data were prospectively obtained from each patient: self-reported medical history; socioeconomic status (SES); occupation; residence; alcohol consumption; tobacco use; self-reported history of malaria, tuberculosis, and other recurrent infections; medication use; New York Heart Association functional class; cardiac symptoms and signs; family cardiovascular disease history; and physical activity. Heavy or hazardous alcohol drinkers were identified using
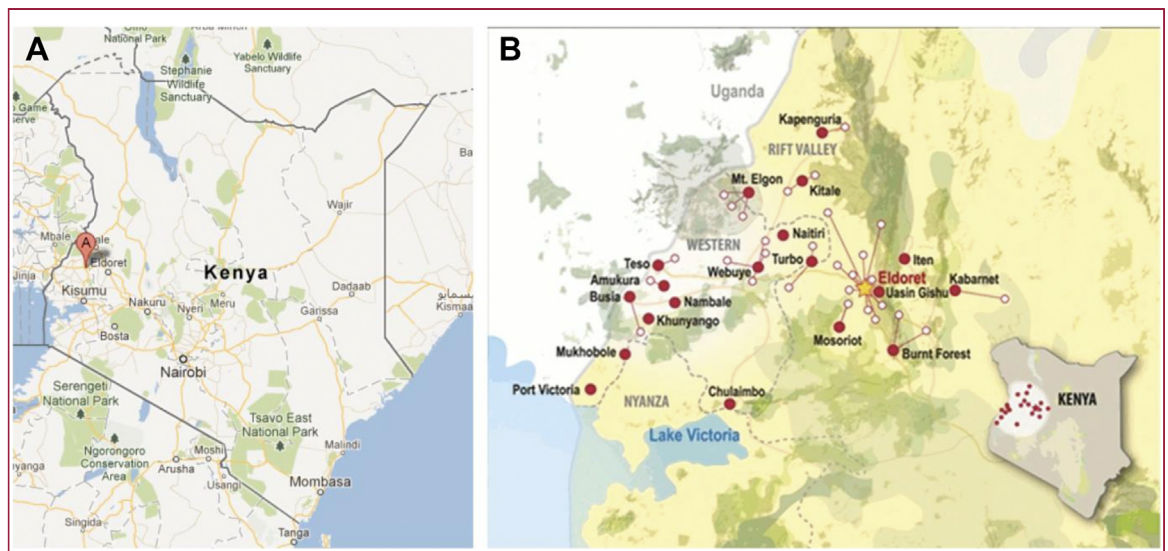

FIGURE 1. **Map of the study catchment area**. (A) Kenya. (B) Academic Model Providing Access to Healthcare (AMPATH) catchment area in western Kenya. This study was carried out in Eldoret, Kenya (red type).