GLOBAL VOICES

Electrophysiology practice in low- and middle-income countries: An updated review on access to care and health delivery

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Concurrent with the epidemiological transition to cardiovascular diseases in low- and middle-income countries (LMICs), the burden of arrhythmias is increasing significantly. However, registries of electrophysiological disorders and their management in LMICs are limited. The advancement of telemedicine technology can play a distinctive role in providing accurate diagnoses in resource-limited settings. The estimated pacemaker implantation requirements (1 million per year) demand an alternate source of pacemakers, including reused permanent pacemakers and implantable cardioverter-defibrillators. In addition, the majority of supraventricular tachycardias and atrial fibrillation can be managed with radiofrequency ablation, which not only is cost-effective but is curative for most patients.

KEYWORDS Africa; Atrial fibrillation; Cardiac implantable electronic device; Pacemaker; Subcontinent; Supraventricular tachycardia

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Introduction

There has been a transition to noncommunicable diseases in low- and middle-income countries (LMICs) as a result of improved socioeconomic conditions. The leading noncommunicable diseases are cardiovascular diseases (CVDs).[1] Whereas high-income countries (HICs) have CVD death rates of approximately 38%, the overall CVD death rate in LMICs ranges from 10% in sub-Saharan Africa to 58% in Eastern Europe.[2] The overall age-adjusted death rate attributable to CVD, based on 2018 data, is 217 per 100,000, and more than 75% of the 18 million CVD deaths occurred in LMICs.[3] Although many global efforts to prevent CVDs are being made in HICs and LMICs, cardiac arrhythmias and their mortality remain a neglected group, especially in LMICs. Arrhythmia treatment and contemporary device therapy require focused subspecialty expertise and modern high-tech equipment not uniformly available in LMICs. Many endemic diseases of LMICs, such as malaria, dengue fever, and rheumatic heart disease (RHD), manifest as atrioventricular (AV) conduction defects or various atrial and ventricular arrhythmias.[4,5] In this review, the access to care, health delivery, diagnostic challenges, and treatment options are explored from the perspective of electrophysiology (EP) practice in LMICs.

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Epidemiology of arrhythmias in LMICs

AV block

The epidemiology of AV conduction defects and sinus nodal dysfunction is not well defined in LMICs. A survey on cardiac implantable electronic devices (CIEDs) in 2011 demonstrated that only 2 African countries (Sudan and South Africa) participated, and more than 90 countries did not have any national databases (including Pakistan).[6] Limited data are included in international societies guideline/consensus documents (eg, European Heart Rhythm Association, Heart Rhythm Society, and Cardiac Electrophysiology Society) for CIED statistics from most LMICs.[7] The Pan-African Society of Cardiology (PASCAR) report on CIED and EP procedures in 31 African countries showed that 20% of sub-Saharan Africa did not have permanent pacemaker (PPM) facilities and needed humanitarian missions to treat atrioventricular AV block (AVB) or send patients to other countries for PPM implantations.[8]

A marked variation is also observed in the cost of these procedures across many LMICs, with the average cost exceeding the mean monthly income of most patients, making the financial aspect a major barrier to optimal treatment of these patients. A follow-up report updating CIED and EP procedure statistics up until 2019 showed the rate of pacing laboratories to be 1 per million population and the operator density of 0.158 operators per million population per country in Africa.[9] The CIED implantation rate of 2.78 per million inhabitants demonstrated no improvement over the

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KEY FINDINGS

- Due to the epidemiological transition to cardiovascular diseases in low- and middle-income countries, the burden of disease on cardiac electrophysiology is growing at a rapid pace.
- With the increased need for cardiovascular implantable electronic devices per year, philanthropic donations of new devices should be supplemented by alternative sources of pacemakers, such as pacemaker reuse.
- Atrial fibrillation is the most common arrhythmia worldwide, and its prevalence is increasing rapidly in low- and middle-income countries; however, guideline-based treatment strategy is poorly implemented in almost all resource-limited settings.
- Most supraventricular arrhythmias should be ablated because ablation is a cost-effective means of eradicating these arrhythmias.
- Female cardiologists should be encouraged to enter the electrophysiology field to compensate for the deficit of trained personnel in this specialty.

2-year follow-up period, indicating a 200-fold gap with the average implantation rates of the United States.[3]

Considering a birth prevalence of congenital heart disease of 9 in 1000, an estimated 200,000 children in India have congenital heart disease.[10] Congenital heart block is estimated to occur in 1 in 15,000–22,000 births in the United States, but accurate estimates of congenital heart block are largely missing from LMICs.[10] Only case reports are available from sub-Saharan Africa. Case reports of congenital heart block from Africa consist of some cases of lupus neonatal syndromes associated with Ro and La antibodies.[10]

A study determined the etiology of heart block in patients ≤55 years old who were treated with transvenous pacemakers in South Africa.[11] Third-degree AVB was diagnosed in 73.5%, 2:1 AVB in 8.1%, and Mobitz I second-degree AVB in 5.9%. The etiology of AVB could be determined in 97 of 136 patients (71.3%). Forty-three of 136 patients (31.6%) were postsurgical, and 16 of 136 patients (11.8%) had developed AVB from an acute myocardial infarction. Cardiac magnetic resonance imaging was performed in 26 patients; of these patients, cardiac sarcoidosis was diagnosed in 7, and no pathology could be identified in 10. RHD remains the most common CVD among young adults and adolescents requiring heart surgery in LMICs. Of these patients, 4.3%–79.9% develop tachyarrhythmias.[12] In India, the prevalence of atrial fibrillation (AF) is 23.9% among patients with RHD.[12]

The 11th World Survey of Cardiac Pacing and Implantable Cardioverter-Defibrillators reported fewer than 10 new CIED implants per million in Asian countries compared to 750 per million population in Western countries in 2009.[8] The "real-world" data from India show that only 1 in 5 patients with sinus nodal dysfunction receive a PPM.[7] Figure 1 shows the PPM implantation rates in 2018 from high- and low-income countries.

The Universal Health Coverage Initiative of the World Health Organization (WHO) addresses these disparities of data and treatment in LMICs. The Sehat Sahulat Program in Pakistan was a response to this initiative, providing basic care to the lowest-income earners. Specialty care is not well covered, and many patients cannot pay the remaining out-of-pocket expenses.[13]

Tachyarrhythmias

Tachyarrhythmias, including supraventricular ventricular tachycardia (SVT) and ventricular tachycardia (VT), have been reported to be 2.25 per 1000 person-years in HICs; however, epidemiological data on tachyarrhythmias in LMICs are limited.[14–16] Similarly, most epidemiological studies of sudden cardiac death (SCD) are from HICs. In the United States and Europe, the incidence of SCD is approximately 300,000 annually, or 50–100 per 100,000 in the general population.[17]

Ventricular fibrillation (VF) and VT are the most common rhythms associated with SCD.[18,19] A study demonstrated that 84% of 157 patients who suffered SCD had VT/VF, and 16% had bradyarrhythmia.[20] There is a lack of epidemiological studies from LMICs. Because of the limited prospective data on the incidence and prevalence of SCD, most of the studies in LMICs are autopsy or hospital-based studies.[21–24] Emergency services infrastructure is limited in LMICs, so data on incidence are difficult to establish. A study in Cameroon reported a crude incidence of SCD of 31.3 per 100,000 person-years.[25] A study in South Africa reported an incidence of 6.4 per 100,000 person-years based on the first-response data of out-of-hospital SCD.[26] One study conducted in 4 low socioeconomic regions of China exhibited an overall incidence of 41.8 per 100,000, with regional disparities in the incidence of SCD.[27] Rural communities and low socioeconomic status were deemed predictors of SCD. Among the 38 per 100,000 incidents of SCD reported in Thailand and India, 10% of all deaths were related to SCD.[28,29] Atherosclerotic CVD accounts for up to 60% of SCD in HICs.[30] In contrast, the causes of SCD in LMICs are heterogeneous. In 2 autopsy studies from Ethiopia and South India, coronary artery disease was the leading cause of SCD.[18,31] However, in a study from Nigeria, coronary artery disease was only present in 4%, and hypertensive heart disease was the leading cause of SCD.[19] A large proportion of young patients aged <35 years have congenital coronary artery anomalies, myocarditis, and hypertrophic cardiomyopathy leading to SCD in HICs.[32] Similarly, a Tunisian study demonstrated that hypertrophic cardiomyopathy accounted for 41% of SCDs, and arrhythmogenic right ventricular dysplasia accounted for 13.6% of SCDs.[33] A study from Pakistan reported out-of-hospital SCD of 166 per 100,000 population.[34]

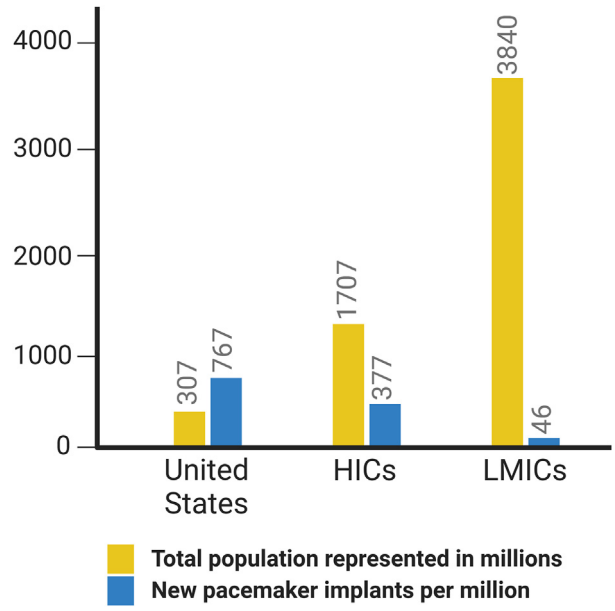

Figure 1 Data from the 11th World Survey of Cardiac Pacing showing the total population presented (in millions) vs new pacemakers implanted (per million).[7,48] HICs = high-income countries; LMICs = low- and middle-income countries. (Image adapted from Bestawros.[48] Made on biorender.com.)

AF

The global burden of AF derives from an estimated 33.5 million people, and AF is the most common arrhythmia worldwide.[35] In the United States, 2–6 million people currently are affected by AF, and the number is expected to rise 2-fold by 2060.[36] The prevalence of AF is lower in LMICs than in HICs; however, this difference can be due to the lack of data from LMICs that likely underestimates the true disease burden. A 2010 LMIC survey showed that the prevalence of AF per 100,000 population was 366.1 for women and 567.7 for men, and the incidence per 100,000 person-years was 40 for women and 53 for men.[3,36]

A systematic review showed a prevalence of 0.03%–1.25% in community-based epidemiological studies of AF in LMICs.[37] Similarly, another systematic review exhibited an annual incidence of 5.38 per 1000 person-years in 8 Asian countries (58 studies).[38] A retrospective study in Brazil (n = 262,685) found the overall prevalence of AF to be 1.8% and anticoagulation use was only 1.5%.[39] The incidence and prevalence of AF are not well established in sub-Saharan Africa, but a few small-scale, hospital-based studies have shown a prevalence ranging from 0.7%–1.5%.[40,41] A study from Pakistan showed a prevalence of 6.5% among acute medical admissions, pointing toward the underestimated burden in African countries.[42] A subgroup analysis from the Randomized Evaluation of Long-Term Anticoagulation Therapy (RE-LY) Registry showed regional disparities in the prevalence of AF, anticoagulation strategies, and risk factors.[43] The investigation concluded there was a lower prevalence of AF in LMICs compared to HICs. The patients in LMICs were younger and had more heart failure (HF) symptoms than those in HICs, and they had a high prevalence of stroke (10%–27%). One-year outcomes showed higher mortality (17%–20%) in Africa and in South American countries compared to the United States, Europe, and Australia (10%).

Diagnostic challenges

The first step to prompt management of any arrhythmia is accurate diagnosis. This requires heart rhythm monitoring in all circumstances. In LMIC rural areas, basic diagnostic equipment (eg, electrocardiographic [ECG] equipment) is unavailable. The average cost of an ECG machine is $1000.44. Other resource limitations include a lack of ECG strips, electrodes, electricity, and expertise. These limitations can result in missed diagnoses of chest pain, syncope, or palpitations. There also is limited access to personnel able to interpret ECGs and a general lack of knowledge on the correct interpretation of ECGs by other health care workers. In a study from 2013 investigating quality-adjusted life-years (QALYs) and the incremental cost-effectiveness ratio using a 7-day Holter monitor to detect AF in patients with cerebral ischemia, 7-day Holter monitoring was found to be cost-effective. Strategies to provide cost-effective ECG monitoring need to be implemented in LMICs.[44,45]

It is imperative to fund low-budget, remote patient monitoring (RPM) device research. One example is a 1-lead ECG recorder, which is sufficient for the most common arrhythmia screening. It has sensitivity of 97% and specificity of 98% in the diagnosis of AF compared to a standard 12-lead ECG monitor with 93% sensitivity and 97% specificity.[46]

Portable event recorders can fulfill long-term monitoring requirements; however, their price limits their use in LMICs because no resources beyond philanthropic donations exist to address access to RPM.

Another diagnostic tool that is limited in LMICs is imaging. Both cardiac magnetic resonance imaging and positron emission tomographic scanning can be useful in making specific diagnoses of nonischemic cardiomyopathies. Infections and inflammatory conditions are associated with both tachycardic and bradycardic rhythms.[47] Chagas disease is endemic to South America but is increasing in other global regions. The availability of advanced imaging techniques could help to make correct diagnoses more rapidly. Tuberculosis is a less common cause of conduction system disease, but timely diagnosis is important because the prognosis of cardiac tuberculosis is good with appropriate treatment.[47]

Access to care and health delivery

Barriers to CIED implantation in LMICs

Most LMICs have the necessary catheterization laboratories to perform device implantations. However, many countries do not have a single operator trained to implant PPMs and follow up on the patients. Because device implantation requires not only procedural expertise but also ~~a~~ long-term follow-up program, the shortage of operators in EP is a challenge.[48] However, along with pacing fellowships in Africa, regional efforts are underway to improve the management of arrhythmias.

Several philanthropic services are being provided during short-term visits from HICs. Nongovernment organizations have provided pacemaker implantation coverage in Bolivia, India, and other countries in Africa for 30 years.[3,49] Furthermore, electrophysiologists are inclined to proctor visits for training local operators in various LMICs. For 20 years, French electrophysiologists have worked to increase CIED implantation in French-speaking African countries in collaboration with Cercle de Rythmologie Africaine (from 0.5 per million to 3.3 per million).[48] PASCAR provides 6 months of fellowship training in cardiac pacing to African physicians and 3 months of training in device follow-up to other medical support staff.[49] There are many challenges to expanding CIED implantation programs in developing countries. Some of the main barriers to implanting CIEDs and performing ablation are the high cost of treatment and the burden on government-run health care systems. Figure 2 shows barriers to EP practice in LMICs.

A single-chamber pacemaker cost-effective model was conducted by the WHO. This model assumed that $773 (US dollars) per life-year saved translated into cost-effectiveness of PPM implantation for every country worldwide.[50] When pacemakers are not available, donations are required from large institutions such as STIMUBANK, which collects previously used pacemakers and ships them to LMICs.[51] PPM reuse has been studied extensively for LMICs and is widely debated in large forums.[52–55] In HICs, many PPMs are explanted after death, infection, or device upgrade. Through initiatives such as My Heart Your Heart, it is estimated that pacemakers can be acquired for about $100 US dollars and then donated to patients who otherwise cannot afford a PPM.[56–58] A meta-analysis of 18 studies reported lower infection rates but high malfunction rates with reused PPMs, with an overall malfunction rate of 0.68%.[58] Another study demonstrated only 1 implantable cardioverter-defibrillator (ICD) malfunctioned among 126 South African countries in the reuse group.[59] In Romania, only 1 battery malfunction was reported among 127 patients with a reused PPM.[60] These programs, which provide reused devices, are expanding to other global regions such as the Philippines and Vietnam and have gained more widespread acceptance.[61–64] Local initiatives also are addressing needs. For instance, the Sehat Sahulat Program awards every person Rs.700,000 annually for medical expenses in Punjab and Khyber Pakhtunkhwa.[13] This program can be used in Pakistan to increase the rate of CIED implantation as indicated by international guidelines. Other issues that need to be considered include ownership of the device (patient, company, state) and patient factors such as cultural or religious concerns regarding the use of devices that had been in another human being.[65] In an ideal situation, everyone would receive a new device, and pacemaker manufactures should continue to improve access to lower-cost devices.

As for SCD, primary and secondary prevention with implantation of an ICD are recommended by all major EP societies for appropriate patient groups. A major randomized clinical trial demonstrated a significant reduction in mortality when an ICD was implanted compared with use of an antiarrhythmic drug (AAD) or no ICD.[16,66–68] However, major challenges in LMICs with regard to ICD implantation include high costs and the lack of experts trained to implant and manage these devices. One study that included patients from major LMICs showed that only 40% of clinically indicated ICDs were implanted in these countries.[69]

One of the major obstacles to ICD use is the cost. An average ICD generator costs up to $40,000, and ICD leads cost $10,000.[70] There is no insurance coverage in the majority of LMICs, and all remaining expenses are paid from the patient's household income.

Although AADs are commonly used to manage recurrent ventricular tachyarrhythmias, they should not be considered superior to an ICD or sympathetic denervation for the prevention of SCD.[71,72] Cardiac sympathetic denervation has been shown to result in improvement in certain patients with ventricular arrhythmias due to channelopathies and structural heart disease.[71] This technique is being investigated as an alternative to CIED placement in South Africa.[72] Of note, however, the risk of SCD in patients with HF is decreasing, and the DANISH (DANish Randomized, Controlled, Multicenter Study to Assess the Efficacy of Implantable Cardioverter Defibrillator in Patients With Non-ischemic Systolic Heart Failure on Mortality) trial of patients with nonischemic cardiomyopathy showed no benefit of an ICD compared to guideline-directed HF medical therapy.[73,74] This finding underscores the importance of providing appropriate HF medical therapy to patients in LMICs.

Setting up ablation laboratories

Although pharmacologic treatment is a viable option in LMICs, it is costlier than catheter ablation over the longer term.[75] One study from Guatemala demonstrated that RFA led to 1.46 QALY gain and saved $5500 per QALY gain.[76] However, there generally is a lack of physician and staff with expertise in diagnostic EP studies, transseptal punctures, and radiofrequency ablation (RFA) in LMICs. Three-dimensional (3D) mapping increases the cost, thus limiting the opportunity to perform many ablation procedures. Therefore, medical treatment is the mainstay of management for SVTs.[77] As with CIEDs, recycled ablation catheters may address the financial challenges. Many ablation catheters can be reused after the ethylene oxide sterilization process without loss of their electrical and mechanical integrity.[78]

Reports from PASCAR have shown that 5 of 23 sub-Saharan African countries were offering ablation for treatment of atrial flutter/AF, accessory pathway, and AV nodal reentrant tachycardia.[8] Only 4 countries (Algeria, Egypt, South Africa, and Tunisia) had 3D mapping systems. In a study from China, the success rate of RFA was >98% for AV nodal reentrant tachycardia and AV reentrant tachycardia in centers where 3D mapping facilities were available.[79] In India, the number of centers is increasing (from 4 to 400 in 2006). However, many countries have a limited number of ablation laboratories, including Pakistan, where EP studies and RFA are performed in only 10 major centers, and targeted atrial

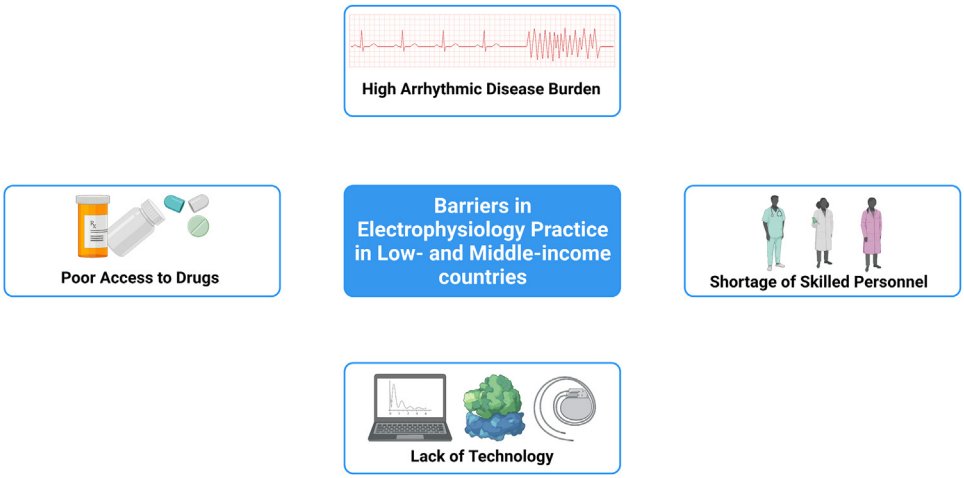

Figure 2 Barriers to electrophysiology practice in low- and middle-income countries. (Made on biorender.com.)

flutter/AF ablation is performed in only 2 centers.[80] Although EP studies and RFA are being performed by medical missions, they do not provide a sustainable long-term solution in Africa and Latin America. The Latin American Society of Electrophysiology and Cardiac Stimulation (SOLAECE) Registry assessed the use of RFA retrospectively in 13 countries (120 centers) in Latin America.[81] Approximately 80% of RFA procedures was performed in Argentina and Brazil, and 3D mapping systems were available in only 49% of SOLAECE centers.[81] An African Heart Rhythm Association survey of cardiac EP services is shown in Figure 3.[82]

Management of AF in LMICs

Common cardiovascular risk factors such as diabetes, hypertension, obesity, and aging are predictors of the increasing overall burden of AF worldwide.[83] The life expectancy of the general population in LMICs is increasing, so traditional cardiovascular risk factors and urbanization will contribute to the growing burden of AF. In addition, RHD, which is prevalent in LMICs, is a major risk factor for AF.[84] The RE-LY Registry demonstrated that hypertension is a major contributing risk factor for AF in HICs, and RHD is a significant risk factor in Africa (prevalence 31.5%) and the subcontinent (prevalence 21.5%).[43]

Identification of AF patients who warrant oral anticoagulation for prevention of stroke is critical. Unfortunately, managing anticoagulation is a challenge in many LMICs. Although warfarin is inexpensive compared to the direct oral anticoagulants, many LMICs do not have clinics to monitor international normalized ratios and manage proper anticoagulation of patients.[85,86]

In the GARFIELD Registry, 36.9% of the population with CHA_2DS_2-VASc score 2 did not receive appropriate anticoagulation.[87] A study in Cameroon showed a low rate of anticoagulation (34.5%).[88] The sub-Saharan and Latin American countries have shown a wide disparity in rates of anticoagulation for AF.[40,88,89] In the RE-LY Registry, the rate of anticoagulation was 65.7% in the United States but only 11.2% in China.[43] Moreover, the time spent in the therapeutic range was only 40% in several of the LMICs.[43]

As noted earlier, catheter ablation of AF is limited because of the high procedural costs and the low numbers of trained electrophysiologists in LMICs. In some centers in Africa, catheter ablation is performed by visiting physicians. Given these limitations, many patients are treated with a rate control strategy. The benefit of catheter ablation of AF in many of the LMICs is limited, particularly in patients with RHD. The reported 70% success rate of first-time ablation many not be cost-effective in LMICs.

There are several obstacles to guideline-directed management of AF in LMICs, as the true burden and management trends in resource-limited settings are not widely understood. Furthermore, international guidelines are reflective of EP practice in HICs, where patients can access advanced therapies that are covered by health care insurance.[90] There are 3 areas of care gaps that, if addressed, could improve care for AF: (1) deficient screening programs for high-risk individuals; (2) delayed or inadequate initiation of anticoagulation therapy; and (3) the lack of LMIC-tailored data to help drive establishment of appropriate care pathways for patients with AF, including catheter ablation. Therefore, the development of a robust CVD health system is essential for enhancing AF care in LMICs to ensure sustainability. Resource modifications, such as appropriate health care staff training, are necessary to bolster the health care system's capacity for diagnosis and treatment. It is important to thoroughly investigate and understand the evidence base supporting the application of current international AF guidelines in LMICs and select the best cost-effective treatment in these settings.

Sex disparity in EP specialty

Although women make up 52% of medical graduates and 42% of internal medicine residents, only 10% continue on to EP fellowships.[91] However, CVD and arrhythmias are

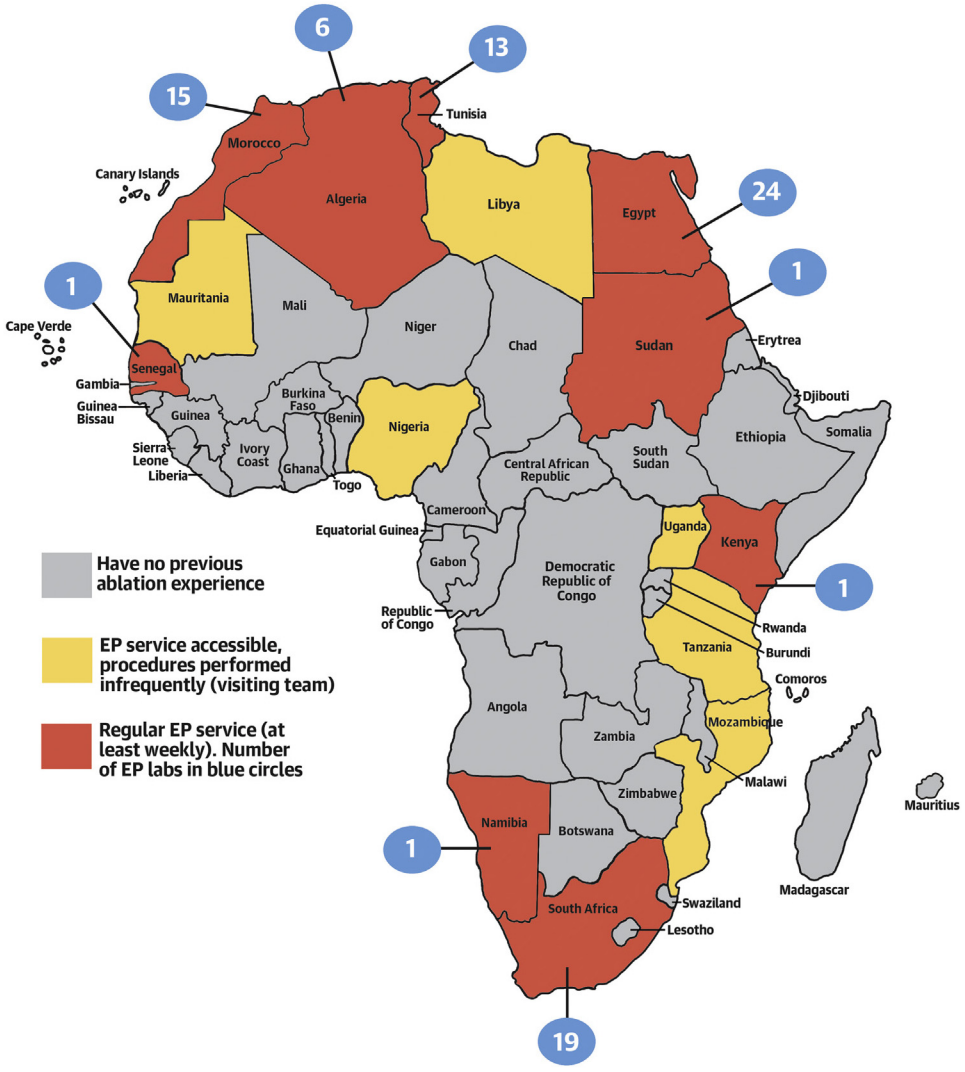

Figure 3 Electrophysiology (EP) services available in Africa. The numbers in *blue circles* represent the number of EP or cardiac catheterization laboratories in that region. (By permission of the authors of "The State of Cardiac Electrophysiology in Africa"[82] and licensed for use in this manuscript from Elsevier number 5370830240623.)

diseases of both men and women with marked sex-specific outcomes, and health care services can resonate well with patients only if the health care team is diverse.[92] Studies show that about 15% of fellows in training choose to go into the EP field, and of those fellows, 10%–16% were women.[93] A number of challenges for women choosing EP have been explored, and the challenges may be even greater for women coming from LMICs.[93] More EP-trained female physicians practicing in LMICs may improve communication with and care of female patients.[94]

Future directions

National device registries should be established in low-resource settings. There is importance in developing national device registries; which are widely accepted; however, there are no guidelines for developing these registries in LMICs. Because device registries provide "real-world" snapshots of patients, stakeholders, physicians, and insurance companies, they can help in the regulation, decision-making, and safety protocols for medical devices. They provide evidence that will be used by funders to decide whether the costs of devices should be reimbursed. They help hospitals with obtaining research grants and making sound procurement decisions. Most importantly, they help patients and physicians to make evidence-based decisions that are in the best interest of the patients.

As a lesser-known subspecialty in cardiovascular medicine, EP should focus on improving education about arrhythmias and awareness of the treatment options that can be provided in LMICs. The key to developing EP care is establishing a strong health care system that ensures CVD management in a sustainable environment. Enhancements to the health care system are needed, including training of health care workers, upgrading the diagnostic capabilities of health care facilities, and establishing emergency response units to medical training camps in remote areas. The rationale for application of standard international management guidelines in LMICs and the identification of cost-effective

interventions in resource-limited settings need to be investigated and understood.

The WHO has proposed Global Action Plan Targets to reduce the death toll from noncommunicable diseases, including training of non-physicians, less specialized, and undertrained health providers to screen for common arrhythmias, use of telemedicine technology for the diagnosis of less common arrhythmias, development of country-specific health care training modules, and implementation of local EP guidelines.[95]

Further recommendations include the provision of essential medicines for treatment of arrhythmias. The PASCAR Task Force convened and reported plans for 2018 to 2022 to institute several actions: (1) PASCAR will validate training centers intended to cover all African countries with pacemaker services by 2025; (2) in collaboration with the My Heart Your Heart and Pace4 Life projects, PASCAR will continue to advance concepts of pacemaker reuse in Africa; (3) the unified task force will estimate the incidence of sports-related SCD in African athletes; (4) an AF registry will be established in Africa under the task force, and barriers to anticoagulation therapy will be identified; and (5) telemedicine will be implemented to improve arrhythmia care on the African continent.

The global impact of AF is determined using contemporary epidemiological data and projections. In conjunction with decreasing the quality of life, the deleterious effects of AF on stroke and HF will add to the economic burden by increasing hospitalizations. The World Heart Federation Roadmap 2020 Update advocates disseminating knowledge on the importance of AF as one of the leading causes of CVD.[96] The continental cardiac societies should lead the campaign to change the treatment strategies in LMICs and provide cost-effective health care resources in order to implement guideline-based therapeutic approaches.

Conclusion

The increased burden of arrhythmias is not being sufficiently addressed in LMICs. In addition, there are no registries to calculate the incidence and prevalence of arrhythmias in many low-resource settings. It is a challenge to implement guideline-directed management of arrhythmias because of the shortage of skilled EP personnel, the absence of infrastructure, and the lack of devices and RFA equipment for treatment of arrhythmias. Cost-effective strategies should be used at the national level to overcome all barriers and limitations to EP care in LMICs.

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