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JACC INTERNATIONAL

Cardiac Pacing Training in Africa



Endorsed by the Africa Heart Rhythm Association (AFHRA):
JACC International

Joselyn Rwebembera, MBChB, FCard,^{a,*} Mohamed Jeilan, MD,^{b,*} Olujimi A. Ajijola, MD, PhD,^c
Mohammed Talle, MD, MSc, MEdSc,^d Mahmoud U. Sani, MD, PhD,^e Kamilu M. Karaye, MBChB, PhD,^e
Matthew F. Yuyun, MD, PhD,^f George Nel, MSc, Ed,^g Loreen Akinyi, BSc,^b Saad Subahi,^h Mervat Aboulmaaty, MD,ⁱ
Felix Sogade, MD,^j Yazid Aoudia, MD,^k Amam Mbakwem, MD,^l Cabral Tantchou, MD, PhD,^m
Mohamed Salim, MD, CEPS,ⁿ Muzahir H. Tayebjee, MBChB, MD,^o Joseph W. Poku, MD,^p
Brian Vezi, MBChB, MPharmMed,^q Bundhoo Kaviraj, MD,^r Marcus Ngantcha, MSc,^s Ashley Chin, MBChB, MPhil,^t
Aimé Bonny, MD, MSc^{s,u}

ABSTRACT

The field of pacing in Africa has evolved in an uncoordinated way across the continent with significant variation in local expertise, cost, and utilization. There are many countries where pacemaker services do not meet one-hundredth of the national demand. Regional, national, and institutional standards for pacemaker qualification and credentials are lacking. This paper reviews the current needs for bradycardia pacing and evaluates what standards should be set to develop pacemaker services in a resource-constrained continent, including the challenges and opportunities of capacity building and training as well as standards for training programs (training prerequisites, case volumes, program content, and evaluation). (J Am Coll Cardiol 2020;76:465-72) © 2020 by the American College of Cardiology Foundation.

Pacemaker implantation in patients with symptomatic heart block is a Class I indication in most international guidelines. No studies have investigated the incidence of heart block or sinus node dysfunction in Africa. With life expectancy increasing in many African countries, it is expected that the incidence of heart block and sinus node

dysfunction will increase. With an estimated population of 1.2 billion people in Africa and a worldwide prevalence of heart block around 0.04% (1), it is likely that an increasing number of patients will require pacing in Africa. Estimates suggest that 1 million people worldwide die every year because of lack of access to pacing; a large number of these are patients



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From the ^aUganda Heart Institute, Kampala, Uganda; ^bDepartment of Cardiology, Aga Khan University Hospital, Nairobi, Kenya; ^cDavid Geffen School of Medicine at UCLA, Los Angeles, California; ^dUniversity of Maiduguri Teaching Hospital, Maiduguri, Nigeria; ^eBayero University/Aminu Kano Teaching Hospital, Kano, Nigeria; ^fHarvard Medical School and VA Boston Healthcare System, Boston, Massachusetts; ^gPan African Society of Cardiology, Head Office, Cape Town, South Africa; ^hShab Teaching Hospital, Department of Cardiology, Khartoum, Sudan; ⁱDepartment of Cardiology, Shams University Hospital, Cairo, Egypt; ^jGeorgia Arrhythmia Consultants & Research Institute, Macon, Georgia; ^kCentre Hospitalier Mustapha d'Alger, Algeria; ^lUniversity of Lagos and Lagos University Teaching Hospital, College of Medicine, Department of Medicine, Lagos, Nigeria; ^mCardiac Centre Shisong, Shisong, Cameroon; ⁿAga Khan Hospital, Department of Cardiology, Mombasa, Kenya; ^oWest Yorkshire Arrhythmia Service, Leeds General Infirmary, Great George Street, Leeds, United Kingdom; ^pGeorgia Arrhythmia Consultants, Macon, Georgia; ^qGateway Private Hospital, Durban, South Africa; ^rDr A.G. Jeetoo Hospital, Department of Cardiology, Port Louis, Mauritius; ^sHomeland Heart Center, Douala, Cameroon; ^tUniversity Cape Town (UCT), Groote Schuur Hospital, Cape Town, South Africa; and the ^uDistrict Hospital of Bonassama, University of Douala, Douala, Cameroon. *Drs. Rwebembera and Jeilan contributed equally to this work. The authors have reported that they have no relationships relevant to the contents of this paper to disclose. The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the [JACC author instructions page](#).

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**ABBREVIATIONS
AND ACRONYMS****AFHRA** = Africa Heart Rhythm Association**EHRA** = European Heart Rhythm Association**HRS** = Heart Rhythm Society**PASCAR** = Pan Africa Society of Cardiology

from Africa (2). Indeed, cardiovascular mortality has been increasing in Sub-Saharan Africa since 1990 (3), primarily driven by the aging population. However, the shortage of diagnostic tools and appropriate infrastructure as well as a sense of apathy amongst practitioners further compound matters (4,5). In this context, there is an urgent need to develop and improve services to diagnose and treat patients with bradyarrhythmias in Africa.

CURRENT NEEDS

Pacemaker implantation requires skill and is a resource-intensive procedure. In Europe and North America, there are set guidelines (which are regularly updated) defining standards for centers and personnel offering pacemaker services as well as providing recommendations on training, audit, and minimal procedure numbers (6). Adopting the standards set in these guidelines in Africa is challenging because of the absence of core national institutions with political and financial strength and expertise to enforce these guidelines. By identifying factors limiting training opportunities for African device implanters (Table 1), appropriate innovative and site-specific measures can be applied to solve this important problem (7,8).

Sadly, there is also no African pacing registry. According to recent Pan-African Society of Cardiology (PASCAR) surveys, pacemakers are not implanted in about 20% of countries in Africa (9,10). Even in countries where pacing is performed, pacing sites and implanters are few; for example, 17 countries (74%) had <5 centers per country. In 2016, the median implantation rate was 2.66 pacemakers (range 0.14 to 233 pacemakers) per million in Africa, which was a 200-fold lower rate compared to Europe. Even in more advanced countries like South Africa (138 pacemakers per million in 2016) and Tunisia (201 pacemakers per million in 2014), implantation rates were still low compared with Europe and the United States. To compound matters, further expertise in electrocardiogram interpretation and rhythm recognition is severely lacking. This coupled with scarcity of the necessary diagnostic equipment (e.g., Holter monitors) means there is a large population who do not get diagnosed correctly. The 4 main barriers to pacing in Africa are the lack of skilled implanters, lack of facilities for implantation, high cost of devices, and lack of government support (5,9,10). Due to the low number of training centers in African countries, the training of skilled implanters often involves formal cardiology training outside the continent.

HIGHLIGHTS

- Studies show that pacing in Africa is insufficient with expertise only found in few cities.
- This paper reflects severe inaccessibility to life-saving treatments, which is an urgent concern.
- This paper reviews historical and current approaches to pacing training in Africa.
- Standards for a high-quality pacing training service in a resource-constrained continent are reviewed with recommendations.

Universal health care initiatives may help improve access, but very few governments prioritize pacing. In the absence of governments' policy to address gaps in arrhythmia care, an approach to building a workforce of pacemaker specialists supported by professional bodies like the Africa Heart Rhythm Association (AFHRA) is likely to improve access to pacing. Apart from employing skilled personnel from other countries with the inherent cost of maintaining them and being dependent on them, national capacity is best addressed by training local specialists. There is therefore a need to harness and coordinate efforts to improve training processes and ensure excellent outcomes for populations living in Africa.

CAPACITY BUILDING IN PACEMAKER TRAINING

Pacemaker training involves 4 main domains: 1) patient selection and preparation including indications, contraindications, and limitations of pacing; 2) procedural implant techniques usually involving a step-wise demonstration of the implant procedure including relevant anatomy and technology, using a combination of schematic diagrams, cartoons, and the use of live or pre-recorded cases, followed by a "hands-on" apprenticeship program under supervision by an experienced implanter; 3) review of complications during the implant and in the early or late post-implant phase with an overview of techniques to manage and mitigate them; and 4) detailed follow-up and pacemaker troubleshooting including remote monitoring.

There are 3 potential routes by which doctors, nurses, and cardiac technologists can be trained in pacemaker procedures as well as device follow-up. These are summarized in Table 2.

1. TRAINING OUTSIDE THE AFRICAN CONTINENT.

Although local fellowships in cardiology exist within Africa, most countries lack capacity to train large numbers of cardiologists within these fellowships and many programs do not offer adequate training.

Longitudinal exposure to pacemaker cases means implanters develop a broad exposure to unselected cases; trainees usually get enough experience with troubleshooting and dealing with complications as well as experience with device follow-up. Trainees generally have to go abroad to get this experience. Unfortunately, very few international institutions have established formal partnerships with counterparts in Africa. Trainees are therefore left to arrange these fellowships individually including registration with the relevant medical boards. Cardiology fellowships usually limit the training experience to a doctor, excluding allied health professionals (nurses and cardiac technologists); the latter need to make their own separate arrangements.

2. DEDICATED AFRICAN PACING FELLOWSHIPS.

Regional fellowships have the advantage of keeping learners close to their base centers. However, misconceptions about the quality of training and procedure numbers have limited the development of these centers (Central Illustration).

The PASCAR fellowship in cardiac pacing was established in 2016 and has trained paired pacemaker implanters and technologists from 3 countries (Kenya, Tanzania, and Sierra Leone) at Groote Schuur Hospital, University of Cape Town, South Africa, through an intense 6-month hands-on program for device implantation and follow-up for doctors and technologists. A fourth implanting trainee from Zambia has started training in the current year. Over 250 pacemakers have been successfully implanted by beneficiaries of this PASCAR pacing program in 3 countries since 2016. A second 6-month PASCAR program has started in Khartoum and currently has an Ethiopian fellow. Post-training mentorship of fellows in their countries is provided by the PASCAR/AFHRA team. A similar 18-month pacing curriculum was launched in Dakar (Senegal) in 2017. Fellows are required to perform 25 second- and 25 first-operator implants and conducted 100 device follow-ups (based on the Colleges of Medicine of South Africa requirement of at least 30 single- and 10 dual-chamber pacemakers as first operator for accreditation in pacing). The success of this approach advocated by the PASCAR/AFHRA is summarized in Table 3.

3. ON-SITE PROCTORSHIPS. A team (including a medical proctor) travels, often with equipment, to

TABLE 1 Factors Limiting Training Opportunities for African Device Implanters

Patient Factors Resulting in Low Clinical Volume	Teaching Factors Resulting in Failed Training Despite Clinical Volume
<ul style="list-style-type: none"> • Failure to get diagnosed • Failure of attending clinician to make a diagnosis • Failure of patient to be offered treatment <ul style="list-style-type: none"> ○ Few practitioners ○ Lack of technology ○ Failure of patient to accept the treatment ○ Cost ○ Safety 	<ul style="list-style-type: none"> • Failure to teach <ul style="list-style-type: none"> ○ Few willing teachers ○ Teachers' perception about safety of procedure, and financial and time costs of teaching ○ Patients' perception about safety of procedure, and financial and time costs of teaching

address local demand ad hoc while providing hands-on training at the primary doctor's center. In general, the local team has some pacing experience. However, there is no standardized curriculum and evaluation is usually limited, apart from a sign-off that the practitioner is competent. A skills transfer-based approach to this method is needed to evaluate its effectiveness. Pre-procedural case coordination is necessary to maximize its effectiveness. The costs are often offset by local industry motivated by sales or paid for by patients or humanitarian initiatives. Unfortunately, these programs can be infrequent; therefore, training is erratic and poor, and the local center becomes dependent on the proctor. This approach is not sustainable. The on-site proctorship approach should be regarded as a complement to regular conventional pacing training programs or an excellent way for hands-on coronary sinus lead placement training, in the setting of a high volume of patients (20 implants per annum over at least 2 training sessions).

CAN HIGH-QUALITY TRAINING EXPERIENCES BE FAST-TRACKED TO IMPROVE ACCESS?

High-volume patient-based training is ideal but may not be deliverable in all centers in Africa. Emphasis on certain traditional training techniques (and the introduction of novel ones) to accompany the apprenticeship/proctorship approaches may complement training. Regional PASCAR pacemaker courses provide a didactic starting point. However, it is important that training programs incorporate theory and practical skills including the use of 3-dimensional models to study anatomy, pacing simulators (excellent for teaching troubleshooting skills and how to deal with complications), and wet labs to help trainees acquire appropriate surgical skills. The use of pre-recorded live cases is also recommended, as well as teaching materials available at the center.

It is important that training opportunities be directed at specific individuals and teams who are

TABLE 2 Models for Pacing Training in Africa

Trainee Suited to This Method		Challenges	Strengths	Weaknesses	Potential Remedies	Suited?
Cardiology fellowship—international	Internal medicine specialist	Minimum 3 to 5 yrs. Costs. Need to increase volume and build confidence after exposure.	Comprehensive. Extensive exposure. Multiple angles. Several fellowship programs worldwide. Usually well established.	Duration. Limited access. International certification requirements. Not all cardiology fellowships train pacing completely. Language challenges in certain countries.	NA	Yes
Cardiology fellowship—regional	Internal medicine specialist	Minimum 3 yrs. Costs. Need to increase volume and build confidence after exposure. Shortage of fellowship programs and slots on the continent.	Comprehensive. Extensive exposure. Multiple angles. Usually in similar social and clinical environment.	Volume. Cultural difficulties allowing trainee to perform procedures. Not all cardiology fellowships train pacing completely.	NA	Yes
Dedicated pacemaker fellowship	Internal medicine specialist; surgeon	6 months needed to increase volume and build confidence after exposure. More resources needed, e.g., online modules.	Focused. Quick turnaround. Modular training.	Limited scope. High-volume centers needed to deliver.	Engaging additional resources for hands-on and offline training.	
Proctorship on site—monthly	Catheter-skills trained practitioner; less-skilled practitioners will take much longer to train				Engaging additional resources for hands-on and offline training.	
Proctorship on site—quarterly or less, e.g., humanitarian camp-based	Catheter-skills trained practitioner; less-skilled practitioners will take much longer to train					

dedicated to the management of bradyarrhythmias rather than individuals who just wish to learn a new technique. Clarity should be sought from the outset as to how they will develop the service and hence be able to maintain their skills before they are selected to enroll in a training program. It is recommended that candidates are interviewed with an AFHRA representative present to ensure transparency and equity.

HOW COULD WE REDUCE THE COST?

Pacing is relatively expensive (infrastructure and consumables), and financial constraints remain a key limitation to sustaining device services in Africa (4,9). The adoption of techniques to resterilize pacemakers (including from abroad) is probably the key in reducing cost and increasing access to this lifesaving technology. PASCAR has adopted this approach, and it is expected that this will lead to more local implants. This would greatly accelerate the process of domesticating level 1 and 2 training in African institutions.

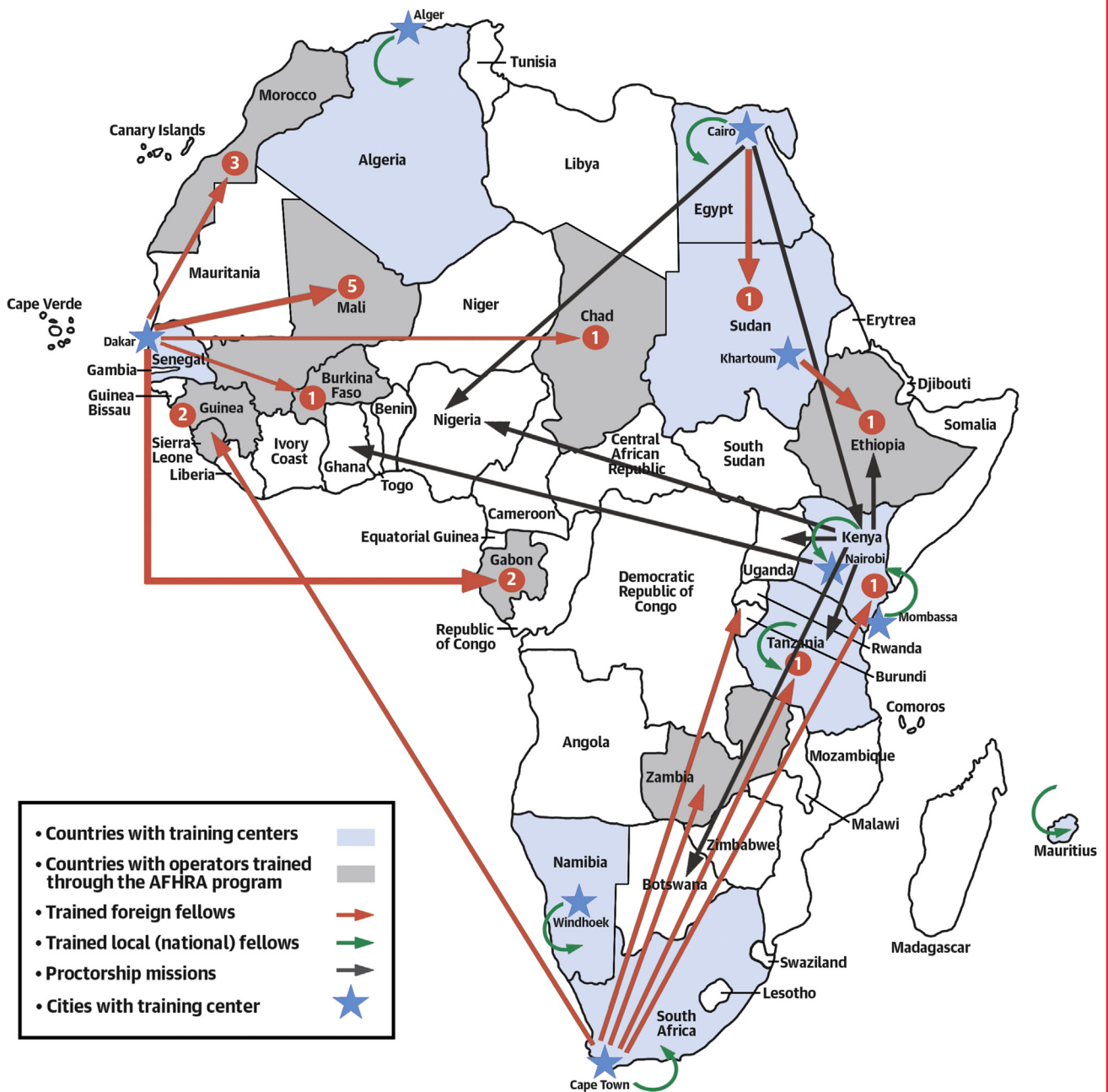
The role of manufacturers in facilitating the delivery of pacing is critical. Collaborating with local governments to subsidize pacing equipment would greatly improve implant rates (9). It is important that the device business model for device companies in

Africa is aligned with ensuring that basic pacing can be accessed by the general population.

PACEMAKER FOLLOW-UP

Device interrogation at implant and during early and late follow-up should be a mandatory part of training and is part of the accreditation process required by the Heart Rhythm Society (HRS), EHRA, and other international societies. Implanters should be able to independently perform device interrogation and troubleshoot. As this expertise is usually drawn through teaching and experience, PASCAR and AFHRA have prioritized regional pacemaker interrogation training. In the past 2 years, 2 such courses have been organized with hands-on training of technologists and cardiologists in East Africa following similar programs in North and Southern Africa. Online resources and industry-specific courses have helped augment formal training, and their utility can be demonstrated through certification processes and institutional or international knowledge-based assessments as with the EHRA, International Board of Heart Rhythm Examiners, and HRS programs. Mentoring with support of locally skilled industry product specialists or remote monitoring by specialists outside the center is an excellent way of providing ongoing teaching. AFHRA can and should participate

CENTRAL ILLUSTRATION Fellowship Training Activities in AFHRA Countries



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Training courses in cardiac pacing (conventional pacemakers, resynchronization and cardioverter-defibrillator therapies) are ongoing in several member countries of African Heart Rhythm Association (AFHRA), the arrhythmia working group of the Pan African Society of Cardiology. These centers of excellence in cardiac pacing receive locals (green arrows) and other African nationalities (red arrows) to train in cardiac pacing. Few proctorship missions (black arrows) are occurring.

TABLE 3 Training Requirements Recommended by AFHRA	
Prerequisites	Short Recommendations
Trainee prerequisites	<ul style="list-style-type: none"> • Qualified physician who has graduated from an accredited medical school and must be licensed to practice medicine in the country in which he or she intends to undertake the device implantation training. • A certified physician with at least 6 months of general cardiology training with the ability to make differential diagnoses and tailored to a specific arrhythmia diagnosis. • Competency and holding active certification in basic life support and advanced cardiac life support. • The trainee pacemaker implanter must be able to access patients and appropriate technology to support the implant on return to their country of origin. This usually requires parallel support from an institution in the clinician's country of origin or from the government.
Trainer and training center staffing prerequisites	<ul style="list-style-type: none"> • Trainer must be a licensed physician in the country of practice, at least 1 trainer is encouraged to be board-certified in electrophysiology and/or cardiac implantable electronic device with the necessary re-certification (e.g., American Board of Internal Medicine, IBHRE, and EHRA). • Competency and active certification in moderate sedation, basic life support and advanced cardiac life support. • Competency in pacemaker implantation, programming, and follow-up in countries where these services exist as part of cardiac rhythm management, and overall management of cardiac device-related issues. • Availability of qualified anesthesiologists or competent anesthesiology nurse specialists. Advanced practice nurses and physician assistants should be used in areas where they will have a maximum impact on patient care and where they can assume roles and responsibilities unique to their training and certification.
Laboratory design	<ul style="list-style-type: none"> • An uninterruptible power supply for all catheterization and computer equipment is required. Lighting should include an overhead light on an articulating arm, 2 × 2 ft lighting squares to flood the main procedure area, and a dedicated workspace light for the nursing/anesthesia area. • The air flow/heating, ventilation, and air conditioning design should comply with the Guidelines for Environmental Infection Control.
Laboratory activity/process	<ul style="list-style-type: none"> • An institutional case load of at least 50 conventional procedures per yr. At least 40 implant procedures per trainee with at least 30 as sole or first operator. Of these, at least 10 should be dual-chamber implants. • An identifiable and dedicated pacemaker and implantable cardioverter-defibrillator (ICD) follow-up service. • Outpatient device clinic (1-week post-implant for wound check, 1-month post-implant for reprogramming to long-term settings, and at least every 6 months, and then 3-monthly when <1 yr from elective replacement indicated). At least 50 pacemaker follow-ups and interrogation episodes required per yr. • Periodic peer review of complications related to device implantation should be carried out. Periodic meetings devoted to implantable device management should be organized. • If cardiac resynchronization devices are implanted, appropriate heart failure follow-up services must be available.
Laboratory environment	<ul style="list-style-type: none"> • Dedicated operating room (ideally electrophysiology laboratory or catheterization laboratory), which should be part of a public or private hospital and is equipped with the necessary and functioning imaging equipment, and a radiographer who has competence in handling fluoroscopic equipment. • The African-based training centers must be recognized and approved for this purpose and accredited by AFHRA before they go operational. These training institutions will also be required to undergo re-assessment every 5 yrs against the set criteria listed above for re-accreditation. • The African training center should encourage and demand that trainees participate in formal assessment of their knowledge and skills upon completion of training. • The recommended knowledge assessment path by the AFHRA for African-based trainees will be passing the physician IBHRE or EHRA device examination for implanting cardiologists or Allied IBHRE for cardiac device allied professionals, after 2 yrs of experience with devices.
AFHRA = Africa Heart Rhythm Association; EHRA = European Heart Rhythm Association; IBHRE = International Board of Heart Rhythm Examiners.	

in international guideline committees with a view to contributing sections in the guidelines for use in under-resourced countries.

QUALITY ASSURANCE

AFHRA shall continue to oversee the performance of implanting centers and practitioners following training and the transition to independent pacing practices. Centers and practitioners will be required to maintain a log of procedures performed and complications encountered. Each implanting center will be required to set up a quality assurance committee that will periodically (annually) evaluate the procedure and complication logs for the center and for each practitioner. Hospital quality assurance committees will submit annual reports to AFHRA about the center's and each practitioner's performance, which will

be compared with pre-specified key performance indicators.

FUNDING

Funding has been highlighted as a major limiting factor for achieving the desired level of care in most countries in SSA. A program designed with funding limitations in mind is more likely to flourish and be sustainable. Our key strategy is to empower the few institutions in Africa that are already providing pacing services to meet the qualifications of a training center. Most of the training center prerequisites necessitate basic rearrangements and a few additions. Centers that qualify for training will be encouraged to receive trainees while charging minimal fees primarily for training consumables. This will greatly reduce the cost of training. This is

without prejudice to any arrangement aimed at providing advanced training in larger centers inside or outside Africa.

EVALUATION, ASSESSMENT, AND PERSPECTIVES

The relationship between volume and safety has been clearly demonstrated. Completion of training will be confirmed independently through a combination of logbook review and direct observation of procedure skills in at least 4 procedures by 2 independent assessors, 1 of whom should not be a primary trainer. Training that meets only one of these criteria will be considered incomplete.

Even though the task of covering all African countries with sustainable pacing activities is enormous, this is our ultimate goal. Pacemaker reuse programs with monitored safety of effective sterilization will continue to be a major strategy to reduce the cost of devices. Over time, we expect that high-volume procedures will encourage device manufacturers to reduce the cost of new devices as well. We expect some African pacing training centers to become AFHRA-affiliated regional centers of excellence in cardiac pacing. These regional centers will continue to be supported as hubs of pacing training for qualifying African physicians. A “pacing education campaign” across Africa will recruit large numbers of qualifying health practitioners from all African countries to train in pacemaker implantation and management at African training centers and regional centers of excellence. AFHRA will progressively set up strong quality assurance and accreditation committees to oversee the continued maintenance of standards. Advocacy will be a major strategy that AFHRA will employ to extend pacing services. African governments will be encouraged to: 1) cover at least one-half of the cost of pacemaker devices for their nationals; and 2) to install basic C-arms in their national, regional, and district hospitals, because pacemaker implantation does not

necessarily require the most sophisticated cardiac catheterization laboratories.

CONCLUSIONS

In the absence of government policy to address gaps in arrhythmia care, an approach to building a workforce of pacemaker specialists supported by professional bodies like AFHRA will empower local centers with the tools required to develop and sustain a high-quality pacing service. Because engaging skilled personnel from other countries is simply not a viable long-term option, national capacity is best addressed by training local specialists. There is a need to harness and coordinate efforts to improve sustainable local training processes and ensure excellent outcomes for populations living in Africa. Partnerships with other international organizations like the HRS, the EHRA, and the Asian Pacific Heart Rhythm Society will help in driving local skills forward by developing efficient fellowship programs, training standards, and mentorships.

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ADDRESS FOR CORRESPONDENCE: Dr. Aime Bonny, Homeland Heart Center, Douala, Cameroon/University of Douala, BP 2701, Douala, Cameroon. E-mail: aimebonny@yahoo.fr. Twitter: [@BonnyAime](https://twitter.com/BonnyAime).

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