

# Electrophysiology in the Developing World Challenges and Opportunities



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## KEYWORDS

- Electrophysiology • Developing world • Developing countries • Atrial fibrillation • Anticoagulation
- Pacemaker • Stroke • Ventricular tachycardia

## KEY POINTS

- Coincident with the epidemiologic transition in low-income and middle-income countries (LMICs), the burden of cardiac electrophysiologic disorders is significant and growing.
- The growth of handheld and wireless technologies allows a unique opportunity to provide arrhythmia diagnosis in remote areas of the world.
- With an estimated need for 1 million pacemakers worldwide per year, philanthropic donations of new pacemakers need to be supplemented by alternative sources of pacemakers, such as pacemaker reuse.
- Atrial fibrillation rates are expected to increase rapidly in LMICs, but its treatment, especially stroke-preventing anticoagulation, is poorly managed throughout much of the world.
- Supraventricular tachycardias can often be cured by an ablation, which is not only cost-effective, but cost saving.

## INTRODUCTION

In the past 15 years, the United Nations General Assembly has only met once to tackle a global health crisis.<sup>1</sup> The meeting was in 2011, and the crisis was noncommunicable diseases (NCDs).<sup>1</sup> Thirty-eight million people die annually from noncommunicable diseases, and almost 75% of these deaths occur in low-income and middle-income countries (LMICs).<sup>2</sup> Eighty-two percent of premature deaths from NCDs (people aged <70 years) occur in LMICs, thereby disproportionately affecting their citizens during their most productive years. Cardiovascular disease accounts for 30% of all deaths worldwide and has twice the mortality of human immunodeficiency virus, malaria, and tuberculosis combined.<sup>3,4</sup> The burden of cardiovascular disease in LMICs is likely under-recognized.

The disparities in cardiovascular health between high-income countries and LMICs are evident, and there are few fields in which this is more evident than electrophysiology. Not only do arrhythmia treatment and recent advances in device therapy for heart failure treatment often require subspecialized expertise and high-tech equipment that are often not available in LMICs, but endemic diseases such as Chagas disease and rheumatic heart disease often manifest with sinus node dysfunction, atrial fibrillation (Afib), various degrees of atrioventricular block, bundle branch blocks, prolonged QT intervals, premature beats, ventricular tachycardia, and heart failure.<sup>5–9</sup> The diagnostic and treatment challenges of electrophysiology in the developing world deserve to be explored further.

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## DIAGNOSTIC CHALLENGES

The accurate diagnosis of arrhythmias requires heart rhythm monitoring. In developing nations' rural communities, electrocardiogram (ECG) machines are often not available and generally cost \$1000 or more.<sup>10</sup> Even when they are available, lack of ECG paper, limited numbers of electrodes, limited electricity, and limited expertise in interpretation restrict their use. Because of these limitations, patients with syncope, stroke, chest pain, or palpitations do not receive this basic indicated test.<sup>11</sup>

However, resources beyond philanthropic donation exist to address access to ECGs in LMICs. The wide availability of wireless technologies creates opportunities for both obtaining and interpreting basic ECGs. A 1-lead ECG, which is sufficient for most arrhythmia screening, can be obtained with dedicated handheld ECG monitors or smartphone cases with integrated electrodes, such as the AliveCor Kardia monitor (<https://www.alivecor.com>).<sup>12,13</sup> This Kardia monitor can perform HIPAA-compliant transmissions and is 98% specific and 97% sensitive in the diagnosis of Afib compared with 12-lead ECGs.<sup>14</sup> Majors and colleagues<sup>15</sup> presented an ECG chair concept that uses electrodes placed on a clinic chair's armrests to produce a single-lead ECG that could be interpreted locally or transmitted wirelessly. In India, mobile vans equipped with ECGs and satellite terminals can transmit ECGs for expert interpretation.<sup>16</sup> For diagnoses that require more long-term monitoring, devices such as the ZIO Patch by iRhythm Technologies or the Seeq MCT monitor by Medtronic offer more portable options than other Holter and event monitors, although their current pricing structures limit their use in LMICs.

## BRADYARRHYTHMIAS AND PACEMAKER IMPLANTATION

### *Indications*

Two diagnoses require pacemaker implantation: sinus node dysfunction and high-grade atrioventricular (AV) block. Manifestations of sinus node dysfunction vary from mild fatigue or dyspnea to frank syncope. High-grade AV block can be life threatening and, in the developed world, often leads to pacemaker implantation within 24 hours of diagnosis. In the absence of a reversible cause, these diagnoses are treated with a pacemaker.

### *Worldwide Inequalities Based on Income*

The disparity of pacemaker implantation between high-income countries and LMICs is vast. The last world survey of cardiac pacing included 61

countries representing more than 80% of pacemaker and implantable cardioverter-defibrillator (ICD) implants worldwide.<sup>17</sup> Of note, 42 of the represented countries were high income, and more than 100 LMICs did not report any implants (Fig. 1).<sup>17</sup> Germany, France, and the United States all had more than 750 new implants per million population, whereas Bangladesh, Indonesia, Myanmar, Nepal, Pakistan, the Philippines, Vietnam, and Sudan had less than 10 new implants per million population.<sup>17</sup> Outside of Europe and North America, only Australia, Israel, and Uruguay had more than 300 new implants per million population.<sup>17</sup>

These differences affect both individual patients and their communities. The average life expectancy for patients with complete heart block without a pacemaker is 2.5 years.<sup>18</sup> Pacemakers can give back many productive years of life. In a South African study of pacemaker patients between 21 and 50 years old, those without structural heart disease lived as long as controls in the general population.<sup>19</sup> Among patients with and without structural heart disease who were alive 1 year after pacemaker implantation, 70% were alive at 20 years.<sup>19</sup>

## *Barriers to Pacemaker Use in Low-income and Middle-income Countries*

### *Expertise*

Although most countries have the necessary operating rooms and fluoroscopy, pacemaker implantation requires both expertise and long-term follow-up. Some countries do not have a single physician trained to implant pacemakers and follow pacemaker patients. In addition, physicians who go to high-income countries to receive such training often do not return.

Several methods of developing this expertise within LMICs exist. First, philanthropic provision of services through short-term trips are increasingly common. Project Pacer International has freely provided pacemaker implantation in Bolivia for more than 25 years and has expanded its services to India and other countries in South America and Africa.<sup>20,21</sup> Second, electrophysiologists have committed to regular training visits to some LMICs. Over the past 2 decades, French electrophysiologists have worked with the Cercle de Rythmologie Africain to increase pacemaker implantation rates in 12 French-speaking African nations from less than 0.5 per million to 3.3 per million.<sup>22</sup> Third, providing pacemaker training for physicians and technicians without comprehensive electrophysiology training may be effective. The Pan-African Society of Cardiology fellowships

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