

### **Arrhythmia monitoring in the palm of the hand: mobile 1-lead ECG**

The rising prevalence of cardiovascular disease (CVD), the leading cause of death in the USA and Europe,<sup>1,2</sup> has been the impetus for major reforms in treatment and surveillance programs. Modern-day medical care trends have been placing continuously growing emphasis on prevention and early detection efforts, particularly those with life-saving potential. These advances rely heavily on improved communication and advanced telecardiology technologies, which have enabled off-site expert assessment of real-time, objective, measurable clinical data. Such monitoring options have made a marked impact on preventative measures, by extending outreach of specialists, improving communication channels between caregivers, and reducing medical personnel burdens. In particular, the advent of the single-lead electrocardiogram has facilitated massive ECG screening, more judicious hospital admissions, tailored interventions, dosage titration, improved quality of life, significantly fewer deaths and reduced healthcare costs.<sup>3-5</sup> The noninvasive test is rapid and simple, and has been demonstrated a reliable, more feasible and cost-effective alternative triage test to systematic use of the 12-lead ECG in specific situations.<sup>3</sup> Its integration in a standard smartphone jacket, enables readily accessible and highly discreet signal acquisition and transmission, factors ideal for promoting widespread screening and routine follow-up.

Arrhythmia and congestive heart failure (CHF) patients are two patient populations that have gained considerable benefit from such advances in ECG monitoring. Atrial fibrillation (AFib), involving either episodic or chronically chaotic and irregular beating of the atria, is the most common form of arrhythmia, affecting at least 2.7 million Americans, or approximately 9% of the population over the age of 65.<sup>6</sup> AFib is a major risk factor for stroke and systemic embolism, and is consequentially associated with doubled risk of heart-related mortality and five-fold increased risk of stroke.<sup>7</sup> Annual AFib-associated medical care expenditures are estimated at 6 billion USD.<sup>8</sup> While AFib often manifests

by heart palpitations, shortness of breath, fatigue and weakness, in many patients it is often asymptomatic, and only incidentally detected. In fact, previously undiagnosed AFib is detected in 20% of patients with acute stroke or an ischemic event.<sup>9,10</sup> Thus, routine screening is key to identifying silent or early-stage Afib, and has an immediate impact on risk of systemic embolization, stroke prevention and overall management.<sup>11</sup> Intermittent one-lead ECG recordings, interpreted with validated algorithms, have proven adequately sensitive to detect pathological ECG patterns and to significantly reduce the need for manual evaluation.<sup>12</sup> In their comparative, blinded assessment of the accuracy of AF detection by an iPhone-embedded ECG platform versus the standard 12-lead ECG interpreted by a cardiologist, Lau et al.<sup>13</sup> report on the high diagnostic quality of the system, with only one false negative result recorded among the 204 patients, of whom 48 were AFib patients.

Congestive heart failure (CHF), characterized by clinical signs and symptoms, like shortness of breath and leg edema, is caused by cardiac functional or structural abnormality that results in reduced cardiac output and/or elevated filling pressures. CHF afflicts close to 6 million American adults, and approximately 23 million individuals worldwide.<sup>14</sup> Its prevalence increases with age and preventable risk factors include smoking, obesity, lack of physical activity and high salt intake. This life-threatening condition is the contributing cause of one in nine deaths, with almost 50% of patients dying within five years of diagnosis.<sup>15</sup> CHF drains 1-2% of the overall healthcare expenditure, 60% of which is driven by in-patient care.<sup>16</sup> Yet, of the 1 million CHF-related hospitalizations in 2010,<sup>17</sup> approximately 2/3 have been estimated potentially preventable by increased awareness and improved access to high-quality community health and telemedical services.<sup>18</sup> In this respect, routine integration of personal one-lead ECG devices is expected to revolutionize healthcare quality and delivery. Indeed, Scalvini et al. have demonstrated both the feasibility and usefulness of a mobile, one-lead ECG device in monitoring and titrating drug dosages in CHF patients.<sup>4,5</sup>

Apart from enhancing cardiac disease monitoring and care, one-lead ECG trace collection at the fingertips can also relay information regarding the impact of fitness programs on

the heart.<sup>19</sup> This option may present an amiable alternative to the standard stress test, a key barrier to enrollment at fitness facilities.<sup>20</sup> Its deployment has also been described in efforts to significantly reduce the complexity of the standard polysomnography, a test performed for real-time detection of reduced airway patency and subsequent sleep apnea episodes<sup>21</sup> in vulnerable patients undergoing surgical procedures or treatment with specific drug families.<sup>22</sup> In addition to its value in clinical monitoring contexts, the ECG signal has also been ascribed biometric traits, which can be exploited for human identification in a wide array of security and access control applications.<sup>23,24</sup>

In summary, mobile telecardiology harnesses the marked advances in both the communications and medical device arenas. Routine medical monitoring no longer requires large devices in conventional clinical settings and has been replaced by portable, hand-held and user-friendly, hybrid medical-mobile equipment, empowering both patients to proactively monitor their health and for clinicians to better detect and monitor abnormalities. Apart from maximal flexibility and geographic freedom, patients benefit from an inconspicuous means of managing their health, with fewer efforts and at lower costs.

The Prizma G2 plug-and-play medical smartphone case integrates a series of biometrics-measuring modules to support simple, rapid and noninvasive medical-grade assessments of patient status, at maximal convenience. Its 1-lead ECG feature provides for remote monitoring and management of arrhythmic irregularities. The stored information presents an up-to-date medical history in the palm of the hand, at all times and at any location, heightening surveillance effectiveness, with measurable implications on healthcare costs and risk management.

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