Chapter 11
Advancements in Cardiovascular Diagnostics

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ABSTRACT

The cardiology diagnostic are the methods of identifying current or past heart conditions, which can advise caregivers on patient diagnosis and provide a proper therapy plan, nowadays couple new diagnostic methods have been developed and some of them like radionuclide myocardial perfusion imaging, coronary computed tomography angiogram, cardiac magnetic resonance imaging, intravascular ultrasonography, optical coherence tomography, intravascular thermography, intravascular elastography, and near-infrared spectroscopy have been approved for clinical use. Not only the advanced technologies, the new biomarkers, and genetic markers may provide new potential targets for the diagnosis, therapy, and prevention of heart diseases.

INTRODUCTION

Since the x-ray was first applied to the chest in 1895 and the original galvanometer electrocardiogram was created by Dr. Willem Einthoven in 1902, cardiologists have been working to augment their history and physical exam with new objective information gleaned by the various technological advancements of each historical era. The first three-lead electrocardiographic machine was bought for everyday clinical use in 1908 by Sir Edward Schafer of the University of Edinburgh, and was used primarily to study arrhythmias. The idea of the myocardial infarction developed in 1910, and it was found by 1930 that the readout from an electrocardiogram could often produce patterns pathognomonic enough to diagnose cardiac-related chest pain. By 1954, the electrocardiogram had gradually developed into the 12-lead

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system used ubiquitously today by family practitioners and cardiologists alike (AlGhatrif & Lindsay, 2012). From these beginnings, the field of cardiovascular diagnosis has burst forth in leaps and bounds: within the last 25 years, ever-improving imaging techniques and laboratory assays for increasingly sensitive and specific biomarkers for cardiac muscle disruption have taken their places next to the electrocardiogram as pillars of cardiovascular diagnosis and care (Dolci & Panteghini, 2006). This chapter works to provide an updated snapshot of the current field, with a focus on areas in which great improvements have been made in the last few decades and a nod to the great discoveries now visible just beyond the next bend in the road.

Advancements in Disease Diagnosis

Real-Time Cardiac Monitors

The electrocardiogram (EKG) excels as a first-line diagnostic tool in cardiology because it is a noninvasive, inexpensive, and well-established test capable of providing a wealth of diagnostic information. The 12-lead system may not have changed in the last 60 years, but improvements and new applications are always of interest. One new direction in which the use of EKGs has been rapidly expanding is in monitoring at-risk patients in the community as they go about their daily lives. There is only so much any stress test in the hospital can show – many arrhythmias have previously gone undetected until they cause severe cardiac events, because it has been impossible to analyze a patient's intermittent arrhythmia unless the EKG is performed while the pathologic heart rhythm is actively happening.

The Holter monitor, a small battery-operated recorder that is capable of recording 2 or 3 channels of the standard 12-lead EKG, has been the mainstay of ambulatory monitoring since its inception in the 1980's(Barry, Campbell, Nabel, Mead, & Selwyn, 1987). The Holter can record patient-activated event markers, and it is cheap and records continuously, thereby allowing for the detection of asymptomatic arrhythmias. Unfortunately, monitoring in this way is limited, usually to 24-48 hours at a time. Wearing the device, with its external electrodes, may do more than inconvenience the patients for a day or two; it may also deter patients from going about all of their normal daily activities, thus causing the Holter to miss any arrhythmias generated by motions or situations which the patient avoids out of discomfort(Giada, Bertaglia, Reimers, Noventa, & Raviele, 2012).

Since then, new devices have been developed which are capable of transmitting information via telephone lines to the hospital, of storing and sending information recorded in the minutes before activation (loop recording), and of recognizing when an arrhythmia is occurring and activating automatically, then sending the information to a real-time station monitored by medical personnel.

Most recently developed and approved by the Food and Drug Administration of the United States (FDA) is the implantable cardiac monitor (ICM) (Rome, Kramer, & Kesselheim, 2014). These monitors combine the loop recording abilities of previous monitors with automatic detection of arrhythmias and wireless transmission of data. They are no different from their un-implantable cousins in storing a one-lead ECG tracing but have the added capability for long-term monitoring up to 36 months (Giada & Bartoletti, 2015; Giada et al., 2012). The other monitors mentioned above have had a maximum of 3-4 weeks' monitoring life, so this is a more than 36-fold improvement.

The ICM implantation procedure is minimally invasive and simple enough to be done in the outpatient setting. A subcutaneous pocket is created by a small skin incision, the monitor is inserted and anchored to the muscular plane, and then the pocket is closed and an external programmer used to make sure the

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