The Excitable Heart

Part III: Detecting Cardiac Arrhythmias

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Like a metronome, our heart maintains a steady beat helping us to keep time with the musical interludes of life. But that faithful pace can be interrupted, slowed or accelerated disrupting the harmony of our lives. As discussed in part II of this series, cardiac arrhythmias can take many forms ranging from single extra beats sensed as occasional palpitations to totally uncoordinated contractions known as fibrillation. Fibrillation of the upper chambers of the heart (atria) usually leads to a fast somewhat irregular heart rate, accompanied by fatigue, chest discomfort and, in people with coronary disease, anginal pain. Fibrillation of the main pumping chambers (ventricles) is a bit more serious in that it leads to death unless reversed in a timely manner. Between these two extremes exist a wide variety of irregular rhythms that impact on the quality of our lives and in some cases are life-threatening.

Detection of an arrhythmia, the most important first step in dealing with the problem, is at times easier said than done. Physicians have a number of tools in their armamentarium to tackle this problem. The most important is the electrocardiogram or ECG. This wonderful device records the electrical activity generated by the heart at the body surface. You may recall from our discussion in Part I of this series, that although the heart is a muscular pump, each of its beats is initiated and finely regulated by electrical activity generated by the flow of ions across the cardiac cell. The humps and bumps recorded by the ECG provide your doctor a wealth of information about the condition of your heart. It can tell him whether your heart is functioning normally or whether your heart is beating too fast, too slow or unevenly, or whether it is deprived of oxygen or enlarged. If it is beating too slow, the ECG will reveal whether this is due to a problem with your primary pacemaker, the sinus node, or the "gatekeeper" that controls the flow of impulses from the atria to the ventricle known as the atrioventricular (AV) node. If it is beating too fast, the ECG will indicate whether this is due to rapid generation of electrical impulses in the atria or ventricles and provide the physician some clue as to the mechanism of the tachycardia (fast rate), flutter (very fast rate) or fibrillation (ultrafast rate due to disorganization of the electrical impulse leading to uncoordinated contractions). The ECG will also reveal whether a patient may have suffered a heart attack recently or at some time in the past and whether a congenital heart defect should be suspected. Electrocardiograms can even predict whether a drug like erythromycin, a widely prescribed antibiotic, may be life-threatening to some people. Although medical science and ECG interpretation have advanced considerably in recent years, our understanding of the ECG remains incomplete and is one of the areas of study at the MMRL.

One of the principal difficulties in dealing with arrhythmias is the ability to catch up with them, for they are often elusive, appearing for short periods of time and then subsiding for hours, days, weeks or even months. Although infrequent, they may be troublesome

causing occasional dizzy spells as in the case of paroxysmal tachycardia and may even be deadly as in the case of ventricular fibrillation (sudden death) or Torsade de Pointes. The physician has additional tools at his disposal to detect these isolated events and when necessary to provoke them. The first of these is non-invasive and involves the attachment of several stick-on electrodes to the chest wall which are then connected to a *Holter monitor*. This device is a miniaturized portable ECG recorder generally worn for a period of 24 or 48 hours. Data are recorded on small cassette tapes which are analyzed at the doctor's office or clinic. Holter monitors detect arrhythmias that are intermittent but frequent, but are unlikely to detect those that appear once a week or once a month. This limitation is circumvented by devices called *event recorders* which are miniaturized ECG recorders worn for much longer periods and activated by the patient when symptoms occur. These units not only record the ECG but are capable of transmitting it to the physician over the telephone. Another device that has proved extremely helpful in uncovering intermittent events is the implantable loop ECG recorder. The implantable loop recorder is a small device that is inserted under the skin below the collar bone, usually on the left side, in a simple procedure. Following injection of local anesthetic, a small incision is made and device is inserted. The skin is then sutured closed. The device records a continuous ECG for up to 2 years. If the patient experiences an episode of dizziness or fainting the device is activated to save the recording before, during, and after the episode. The recordings can then be evaluated by a physician to help determine the cause of the event.

When these methodologies fail to detect suspected arrhythmias, the physician may resort to an electrophysiological (EP) study. This procedure is usually recommended for patients who have previously experienced life-threatening events. An EP study involves the insertion of a cathode electrode into the heart through either an artery or vein in the groin, arm or neck. Electrical impulses are introduced through the electrode to stimulate the heart and provoke the arrhythmia. Recordings of local activity within the heart may be obtained with the same or different electrode to localize the region of troublesome activity. Drugs may be tested during the EP study to assess their ability to prevent the induction of the arrhythmia. Alternatively, a special catheter may be introduced into the heart to destroy the tissue that is giving rise to the erratic electrical activity by using radiofrequency energy to heat the tip of the electrode. Known as *catheter ablation,* this procedure has gained considerable popularity as the procedure of choice in the treatment of a variety arrhythmias, including AV nodal tachycardia and the Wolf-Parkinson-White syndrome.

These diagnostic procedures and therapeutic modalities are available today because of many years of painstaking research conducted at medical research laboratories worldwide. Among the laboratories that have contributed fundamentally to our present day knowledge of cardiac electrophysiology and arrhythmias is the Masonic Medical Research Laboratory. For over fifty years, scientists at the MMRL have worked to define the function of the heart in both health and disease. On-going research continues to focus on the mechanisms of arrhythmias, how they can be prevented and controlled; how drugs like erythromycin can produce them and what the various waves in the ECG are trying to tell us. In coming segments of this series, I hope to expand on specific arrhythmias, their causes, treatments and, in some cases, cures.

The Masonic Medical Research Laboratory (MMRL) is a 501(c)3 not-for-profit corporation founded and sponsored by Freemasonry. Recognized as a one of the finest biomedical research centers in the world, the MMRL has contributed importantly to the modern day practice of cardiology. Over the past five decades MMRL investigators have been credited with either discovering or unraveling the mechanisms of a majority of known cardiac arrhythmias and is currently one of a handful of medical research institutes worldwide capable of studying the genetic causes of the lethal cardiac arrhythmias responsible for sudden death in young adults, children and infants. The MMRL is leading the way in the development of innovative safe and effective pharmacological treatment for atrial fibrillation, one of the greatest unmet medical needs facing our society.

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