



Electrophysiology Testing

Basic Facts

Electrophysiology (EP) testing examines the electrical function of the heart from inside the heart itself using small catheters.

EP tests are used to diagnose arrhythmias or to determine the exact cause of and plan treatment for an already identified arrhythmia.

During an EP test, the physician can monitor the heart's electrical function or stimulate the heart with electricity to produce and observe the effects of an arrhythmia and map the site it comes from.

The four chambers of the heart are connected by an intricate electrical system that controls the rate and rhythm of the heartbeat. Electrophysiology (EP) testing uses catheters (long, thin tubes) and electrodes to diagnose problems in the heart's electrical system and to develop a course of therapy for these problems.

EP tests are used to diagnose arrhythmias, or disturbances in the rate or rhythm of the heart. Radiofrequency catheter ablation is sometimes performed as part of the EP test to destroy small amounts of heart tissue that is interfering with electrical impulses.

PRE-TEST GUIDELINES

People scheduled for an EP test should not eat or drink anything for 8 to 12 hours before the test. Because of the unpredictable length of the test, it is often recommended that the patient use the bathroom immediately before it begins.

People taking anti-arrhythmic medications may be advised to stop taking them prior to an EP test, but other medications often may still be taken.

WHAT TO EXPECT

The site where the catheters will be inserted is cleaned, shaved, and numbed with a local anesthetic. Other than a sedative, patients having an EP study do not receive any anesthetics because they can alter how the heart functions.

EP tests are typically performed with the patient lying flat on a table with an x ray machine above or on the side of the table. During the EP test, electrocardiogram electrodes are placed on the patient's chest and a blood pressure cuff is placed on the patient's arm.

To perform the test, the physician threads catheters into and through the blood vessels and to the heart. Electrodes on the tip of each catheter pick up electrical activity from the heart tissue and send information to a computer. The electrodes on the tip of the catheter can also be used to send electrical



signals to the heart, called pacing, so that the physician can induce and observe an arrhythmia in the heart.

An EP test can take anywhere from 1 to 6 hours. When the test is complete, the catheters are withdrawn, pressure is applied to the insertion point to control bleeding, and the person usually is asked to remain lying down for 4 to 6 hours. Within 8 hours, most people can often resume normal activity.

POST-TEST GUIDELINES

The results of an EP study can be used to prescribe or adjust anti-arrhythmic medication or may indicate the need for a pacemaker or an implantable cardiac defibrillator.

For arrhythmias that do not endanger normal heart function, no further treatment may be indicated.

POSSIBLE COMPLICATIONS

Complications from EP testing are usually minimal.

Very rarely during EP tests during which physicians induce arrhythmias, some individuals experience serious rhythm abnormalities, including ventricular fibrillation. The EP laboratory is equipped with a defibrillator, which delivers an electrical shock that restores normal heart rhythm.

Other potential complications include:

- Infection at the catheter insertion point;
- Bleeding;
- Blood clots in the vein;
- Perforation of the myocardium, the muscular tissue of the heart;
- Phlebitis, an inflammation of the veins;
- Stroke caused by an embolism, or blood clot; and
- Heart attack.

Atrial Arrhythmias

Basic Facts

An arrhythmia is an abnormality or disturbance in the rate or rhythm of the heartbeat.

Arrhythmias are caused by problems with the heart's electrical system, which normally causes a heartbeat to begin and sends electrical impulses through the heart.

Arrhythmias range from simply annoying but not dangerous to those that produce significant cardiac symptoms or loss of consciousness.



An arrhythmia is a change in the heart's normal rate or rhythm, normally between 60 and 100 beats per minute. Arrhythmias are classified by their location in the heart and by their speed or rhythm. An atrial arrhythmia is an abnormality that occurs in one of the two upper chambers of the heart, the left or right atrium. Arrhythmias are associated with aging and typically happen more frequently during middle age. At least 10 to 15 percent of people older than 70 years experience arrhythmias.

Arrhythmias are the heart's normal response to changing conditions and can be caused by:

- Stress;
- Emotion;
- Sleep; or
- Exertion.

An arrhythmia may require medical treatment when it occurs repeatedly over an extended period or cause symptoms such as:

- Palpitations;
- Light headedness;
- Syncope (fainting);
- Shortness of breath; or
- Chest pain.

Type of Atrial Arrhythmias

Atrial fibrillation. The electrical signal that circles uncoordinated through the muscles of the atria (the upper chambers of the heart), causing them to quiver (sometimes more than 400 times per minute) without contracting. The ventricles (the lower chambers of the heart) do not receive regular impulses and contract out of rhythm and the heartbeat becomes uncontrolled and irregular. It is the most common atrial arrhythmia, and 85 percent of people who experience it are older than 65 years.

Atrial fibrillation can cause a blood clot to form, which can enter the bloodstream and trigger a stroke. Underlying heart disease or hypertension increases the risk of stroke from atrial fibrillation as does age even without heart disease or hypertension.

Premature atrial contraction (PAC or premature atrial impulses). A common and benign arrhythmia, a PAC is a heartbeat that originates away from the sinus node, which sends electrical signals through the upper chamber. It typically occurs after the sinus node has initiated one heartbeat and before the next regular sinus discharge. A PAC can cause a feeling of a skipped heartbeat. Use of caffeine, tobacco, and/or alcohol, or stress can bring on PACs or increase their frequency.

Supraventricular tachycardia (SVT). Characterized by a rapid heart rate that ranges between 100 and 240 beats per minute. SVT usually begins and ends suddenly. SVT occurs when an electrical impulse 're-enters' the atrial muscles. A disorder that a person may have at birth, SVT is commonly caused by a variation in the electrical system of the heart. SVT often begins in childhood or adolescence and can be



triggered by exercise, alcohol, or caffeine. SVT is rarely dangerous, but can cause a drop in blood pressure, causing light headedness or near fainting episodes, and, rarely, fainting episodes.

Atrial flutter. Differentiated from atrial fibrillation by its coordinated, regular pattern, atrial flutter is a coordinated rapid beating of the atria. Most who experience atrial flutter are 60 years and older and have some heart disorder, such as heart valve problems or a thickening of the heart muscle. Atrial flutter is classified into two types, according to the pathways responsible for it. Type I normally causes the heart rate to increase to and remain at 150 beats per minute. Rarely, the rate may reach 300 beats per minute; sometimes it decreases to 75 beats per minute. Type II increases the atrial rate faster, so the ventricular rate may be 160 to 170 beats per minute. As with atrial fibrillation, atrial flutter increases the risk of stroke.

Sick sinus syndrome (SSS). Common among older people, SSS is an improper firing of electrical impulses caused by disease or scarring in the sinus or Sinoatrial node (SA node). SSS normally causes the heart rate to slow, but sometimes it alternates between abnormally slow and fast. A progressive condition, with episodes increasing in frequency and duration, SSS can be caused by:

- Degeneration of the heart's electrical system; or
- Diseases of the atrial muscle.

Sinus tachycardia. The sinus node emits abnormally fast electrical signals, which increases the heart rate to between 100 beats per minute to 140 beats per minute at rest, and 200 beats per minute during exercise. A normal response to exercise or stress, it can also be caused by:

- Adrenaline;
- Consumption of caffeine, nicotine, or alcohol; and
- Heart conditions.

Sinus bradycardia. Associated with impaired impulse generation in the SA node, it causes the heart rate to decrease to fewer than 60 beats per minute. Commonly caused by SSS, drugs like beta-blockers and calcium-channel blockers can also cause sinus bradycardia. Occasionally sinus bradycardia can be caused by impaired conduction of impulses to the atrial muscles.

Wolff-Parkinson-White syndrome (WPW). WPW syndrome occurs when electrical signals fail to pause in the atrioventricular node because an extra pathway allows the impulse to "bypass" the normal pathway; and the syndrome is sometimes called bypass tract. WPW syndrome causes heart rates approaching 240 beats per minute.

Occasionally, impulses can go down one extra pathway and up another, creating a "loop" or "short circuit," (called SVT because of WPW). Patients with WPW syndrome may develop atrial fibrillation and are at increased risk for developing a dangerous ventricular arrhythmia when this occurs.

CAUSES AND RISK FACTORS

Problems with the heart's electrical system or with the muscles' response to the signal can cause arrhythmias. Physicians have categorized arrhythmias to their type:

- **Disorders of impulse generation** – A signal that generates part of the heart's electrical system other than the SA node.
- **Disorders of impulse conduction** – “block” the heart's electrical impulse and prevent it from traveling its normal pathway.
- **Heart attack** – causes scarring of the heart, which can interrupt electrical impulses.

People without heart disease can develop an arrhythmia for unknown causes, but risk factors can include:

- Emotional stress;
- Consumption of alcohol, caffeine, diet pills, and tobacco; and
- Some prescription medications (certain heart drugs and certain cold, cough, allergy medications and anti-depressants).

WHAT ARE THE SYMPTOMS?

The onset and duration of arrhythmia symptoms vary according to its type, frequency, duration, and whether structural heart disease is present.

Common symptoms that people experience may include:

- Palpitations (the sensation of skipped heartbeats);
- Light headedness;
- Shortness of breath;
- Fatigue;
- Chest pain;
- Fainting; and
- Urge to urinate.

Certain arrhythmias may cause fainting, and, occasionally stroke, while others ('silent' arrhythmias) cause no symptoms.

DIAGNOSIS

Arrhythmias can be difficult to diagnose because they can be unpredictable and brief. A physician will typically take a person's medical history, and perform a physical examination, during which the physician may detect an arrhythmia using a stethoscope. Arrhythmias that occur infrequently, last for short periods of time, or do not cause noticeable symptoms, may require more detailed tests such as:

- Electrocardiogram (ECG);
- A Holter monitor (an ambulatory ECG); and/or
- A loop ECG.



TREATMENT APPROACHES

In some cases, arrhythmias may not require treatment. Other arrhythmias can be controlled by treating the underlying cause. Arrhythmias that cause symptoms may require one or more of the following treatments to reduce the number or duration of arrhythmic events.

Medications. Common medications for suppressing arrhythmias include:

- Beta-blockers;
- Calcium channel blockers;
- Digitalis; and
- Antiarrhythmic agents.

Digitalis should not be used for certain arrhythmias, such as WPW syndrome. People with atrial fibrillation are typically prescribed an anticoagulant to minimize their risk of clotting and stroke.

Cardioversion. This procedure restores a normal heartbeat by transmitting a brief electric shock through the chest to the heart. Usually an outpatient procedure that is performed in a hospital while the patient is under heavy sedation or anesthesia, it is commonly used to treat:

- Atrial fibrillation;
- Atrial flutter; and
- Ventricular arrhythmias.

Radiofrequency catheter ablation. A catheter with an electrode tip is positioned on the affected area. The catheter delivers energy to destroy tissue that is interfering with the normal transmission of electrical impulses through the heart. It is most commonly used for:

- SVT;
- Atrial flutter; and
- Certain types of ventricular arrhythmias.

The procedure is being used occasionally for atrial fibrillation.

Pacemaker. A small electronic device that is surgically implanted under the skin near the collarbone. A pacemaker regulates a slow or erratic heartbeat by sending rhythmic electrical charges to the right atrium and right ventricle. Pacemakers are frequently used to treat Sick Sinus Syndrome.

Maze procedure. A physician makes multiple incisions through the atrium. The resulting scar tissue conducts impulses through the heart's electrical system in a way that allows normal conduction but does not sustain atrial fibrillation. Since it is a form of cardiac surgery, it is reserved for those patients who are symptomatic or as an add-on for those having a surgical procedure for another condition.