

# Electrophysiology in Arrhythmia

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I learned recently at the General Assembly of the AMHE in the South Florida Chapter meeting, (April 2024) The United States was under the effect of an epidemic of Atrial fibrillation. Since medical school, we have well understood that an electrical system was in control of our heartbeats. Both upper chambers (right and Left atria) and lower chambers (Right and Left Ventricles) of your heart were dependent of this electrical system which function was to assure the well-being of this vital organ, in imposing the rate and the rhythm of contraction.

An arrhythmia (disorder of the rhythm) occurs when the heart beats are too fast or too slow or simply become disorganized. A specialist in the treatment of the heart rate is called an Electrophysiologist, expert to whom a patient with such known arrhythmia would be referred in the goal of controlling the heartbeats. Some heart rhythm disorders are relatively minor and need only medications but other can be more complex requiring invasive procedures or even an open-heart surgery.

Atrial Fibrillation (A-Fib), Atrial Flutter, Bradycardia, Supraventricular tachycardia, ventricular arrhythmias, and other conditions related to congenital heart conditions are striking examples of diseases which will require the expertise of an electrophysiologist.

Let us define some of the pathologies encountered:

### 1- Atrial Fibrillation:

An atrial fibrillation (A-Fib) is an irregular and very rapid heart rate. This arrhythmia can facilitate the formation of blood clots the heart and increasing the risk of stroke, heart failure and other complications. In this condition, the heart upper chambers (atria) beat chaotically and irregularly without synchronization with the lower chambers (Ventricles). For many individuals, they may remain asymptomatic, causing a fast-pounding heart rate, shortness of breath and tightness of the chest. Episodes of atrial fibrillation can be transient or persistent. This medical condition is not always life-threatening but the frequency of the symptoms can render the situation serious enough to take precautions to avoid strokes. The epidemic of atrial fibrillation seen in the recent years in the united State shas placed a critical burden on such patient and on the healthcare system. If we believe that 32% of global deaths are caused by cardiovascular disease, more than three quarter of these deaths are subsequent to heart attack, stroke and atrial fibrillation with simultaneously increase the risk of stroke. It is the most common arrhythmia in clinical practice. With the worldwide aging of the population, characterized by a large influx of "baby boomers" with or without risk factors for developing Atrial fibrillation, one can understand why the last 20 years have seen and increase in this pathology.

Medications and therapy toward shocking the heart to re-establish the regular rhythm and other procedures to block any faulty heart signals may control this arrhythmia. A person with such arrhythmia may also have an associated problem with the rhythm of the atrium called a "Flutter" and the same treatment above described, is applied to it to block the faulty heart signals.

Symptoms related to Atrial Fibrillation consist in a fast, fluttering or pounding heartbeats (palpitations). Chest pain, dizziness, fatigue, reduced ability to exercise, Light-headedness, Shortness of breath, Weakness. Symptoms may last few minutes to hours or last as long as a week. Symptoms may go away and come back. These episodes can happen repeatedly and never go away on their own. Some patients may need to be treated for with medical treatment to regularize the heart rate. If the symptoms are persistent and signs of atrial fibrillation are constant and lasting longer than a year, procedures to regularize the heartbeat may be necessary. If symptoms are permanent, medications to prevent blood clots may be given.

To understand better the causes of atrial fibrillation, we will remember the existence of four chambers, two upper (atria) and two lower (ventricle). The two upper chambers are directed by the "sinus node" which control their heartbeat. Such signal move across the upper heart chambers to reach the AV nodes prior to go to the lower heart chambers. Generally. In a healthy individual, the resting heart will beat between 60 and 100.

In Atrial fibrillation, the signals in the upper chambers of the heart are chaotic forcing the upper chambers to tremble or shake. The AV node is flooded with signals trying to get to the lower heart chambers. This defect causes a fast and irregular heart rhythm. But in atrial fibrillation, the signals in the upper chambers of the heart are chaotic. The rhythm which may range from 100 to 175.

Causes of atrial fibrillation can be due to directly to a heart disease and its health problems like in a congenital heart defect. It may also follow a sick sinus syndrome or a sleep disorder called obstructive sleep apnea, a heart attack or a heat valve disease. People with high Blood Pressure. Lung disease (pneumonia), coronary artery disease, Thyroid disease, viral infections. Some people may have atrial fibrillation just by drinking habits with too much coffee or alcohol, smoking tobacco or taking illicit drugs, taking medications containing stimulants or antihistaminic or cold medications. Finally, people who have undergone heart surgery or suffering from any sickness causing an atrial fibrillation.

Some risks factors can be added in relation to older age, the use of nicotine, caffeine and illicit drugs such as amphetamines and cocaine which can make your heart beat faster and lead to the development of more-serious arrhythmias. Alcohol in excess may affect the electrical signal of the heart causing atrial fibrillation. Body mineral and electrolytes like Potassium, Magnesium, Calcium, Sodium in excess or in defect may cause irregular heartbeats.

There may be an increase risk of atrial fibrillation in some families. The same in family with coronary heart disease, heart valve problems present at birth which may increase the risk of Atrial Fibrillation. Any heart attack or heart surgery can trigger such condition.

An individual suffering from high blood pressure has an increase chance in developing coronary artery disease and over time the heart may become stiff and thick. Obesity carries a high risk of developing atrial fibrillation. Diseases like Diabetes Mellitus, Chronic Renal Disease, Lung disease, Sleep apnea can contribute to Atrial fibrillation. We did mention some medications for thyroid, cough and cold triggering irregular heartbeat.

In conclusion, blood clots represent a dangerous complication of atrial fibrillation (AFib) and can lead to stroke. Such risk increases with age and can also be seen with disease already mentioned above like High blood pressure, Diabetes Mellitus, Heart failure, Disease of the heart like in valvular disease. Often, such patients will require the addition of a blood thinner medication.

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**Atrial flutter** is another abnormal heart rhythm, an arrhythmia that occurs when a short circuit in the heart causes the upper chambers (atria) to pump very rapidly. Atrial flutter is important not only because of its symptoms but because it can cause also a stroke that may result in a permanent disability (stroke) or death.

During an atrial flutter, a normal heartbeat is initiated by the electrical impulse from the sinus node, a command center in the heart's right atrium (right upper chamber) while the short circuit — a circular electrical pathway — allows the electrical impulse to quickly move around the right atrium, causing between 240 and 340 contractions per minute. Rapid contractions prevent the chambers (atria) from filling completely between beats.

The ventricles (lower chambers) will try to follow the faster beat of the atrium, though not usually quite as fast. The rate is based on the ratio of atrial beats to ventricular beats. For example, a 2:1 block means that for every two beats in the atria, the ventricles beat once.

This arrhythmia centered in the upper chambers of the heart is called a supraventricular tachycardia (SVT) or fast beat above the ventricles. The atrial flutter is classified as typical or atypical depending on the location of the short circuit

Note that when you feel your pulse — for example, at your wrist or neck — you are feeling the beat of the left ventricle as it pumps blood to your arteries with a normal rate between 60-80 to 100 beats. In the pathway of a flutter, the electrical signal move too fast around the heart while the symptoms remain similar. But treatment will need to differ.

A typical atrial flutter is located in the right atrium and such flutter can be cured with an outpatient catheter ablation procedure... while the atypical atrial flutter which arise from the left atrium may need a more prolonged catheter ablation procedure.

The symptoms of an atrial flutter may vary from no symptoms at all to stroke, palpitations, dizziness or fainting, shortness of breath and fatigue. Symptoms are usually age-related and occurred rarely before the age of 50, but may become more common later. People who experienced previous cardiac surgery or previous catheter ablation for the atrial fibrillation may develop more problems.

After inefficient heartbeats, blood left in the atrium encourages the formation of blood clots. These clots can travel through the systemic circulation and from the heart through the bloodstream. It could then lodge anywhere transported by an artery and cause a stroke. If the extra heartbeat persists, the patient can develop a cardiomyopathy (heart muscle).

How can we diagnose an atrial flutter? An electrocardiogram (ECG or EKG) may reveal changes and the catheter through a vein into your heart may allow the cardiologist interventionist or the electrophysiologist to study better the irregular heartbeats and perform the study under sedation. He will look for abnormal signals and can know their origins to allow proper treatments. It is possible as well that the atrial flutter disappears. In anyway, if the symptoms persist, a procedure called a catheter ablation can be preformed to destroy the errant electrical pathways while an electrophysiological study is parallely performed. Another procedure is a Cardioversion where a controlled shock to the chest is done under. anesthesia to provide a short-term correction of the heart rhythm. More, medications to control the heart rhythm (arrythmia) can also be effective in the management but should be less effective than the catheter ablation. Finally, medication to prevent blood clotting should be added to th

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**Sinus Bradycardia** is defined as a arrythmia in which the resting rate of the heart is less than 60 beats per minute. This can be well tolerated until it drops to the fifty's per minute. Here again, the sinus node controls the rhythm and controls the P wave on an ECG (EKG). This sinus bradycardia in itself does not cause any change in the QRS complex and the T wave. The frequency of a sinus bradycardia is unknown in the general population but in cardiac patient, it is estimated to be 3/5000.

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**Supraventricular tachycardia (SVT)** is a rapid heart rate (tachycardia) caused when electrical impulses originating from the atrioventricular node (AV node) are out of synch with a heart beating between 100 and 300 per minute. It can be a paroxysmal supraventricular tachycardia (PSVT) or paroxysmal atrial tachycardia (PAT) and may exhibit changes in the rate independently of exercises, stress or other common accelerating the heart rate. For many SVT is not dangerous because the heart continues to pump blood through the body. It arises in

people at their teens and 20's which may become symptomatic on and off. Others may present with palpitations, a racing heart with profuse sweating, feeling of lightheaded or dizziness. Often, it may require treatment if it last a long time and causes shortness of breath or chest pain. Keep in mind that other health conditions or family disorders can exhibit signs of Supraventricular tachycardia like in Wolff-Parkinson-White syndrome or other familial disorders and even post-surgical treatment.

To diagnose SVT, a thorough physical examination with pertinent questioning on any fast or irregular heart rate conditions, should point out the examining physician toward such diagnosis. An electrocardiogram (EKG, ECG) to measure the heart's electrical activity and record SVT events will bring the principal clues to assist a diagnosis of SVT.

Treatments for SVT include medications to be taken at the onset of symptoms, and "vagal maneuvers" to try to slow down the heart rate through coughing, gagging or washing the face with cold water or even blowing into your fist. If symptoms are not resolved, it is suggested to reach an emergency room where a fast-acting medication or even electrical cardioversion-procedure can be used to reset the heart's rhythm. Additional medications to manage SVT on a regular basis may be prescribed to slow down the heart rate and prevent further onset of SVT. More definitive treatment can be provided with catheter ablation procedure, which may destroy the part of the heart causing the problem. This is the gold standard procedure able to provide a 99 percent success rate. It is believed that certain triggers like alcohol, caffeine, smoking, some over-the-counter decongestants, diet pills, and drugs such as cocaine and methamphetamine can be detrimental to the health of the one prone to such pathology.

- 4- Ventricular arrhythmias are abnormal heartbeats which originate in the lower heart chambers (ventricles). These arrhythmias cause your heart to pump too fast, preventing oxygen-rich blood from circulating to the brain and body, and may result in cardiac arrest. Ventricular arrhythmia can be asymptomatic and can be detected by an irregular pulse on a routine ECG, in a routine examination at a hospital or on an exercise test. They can also be manifested by palpitations, dizziness, exercise intolerance, syncope or cardiac arrest. An ambulatory monitoring is useful to record the cardiac rhythm on a resting ECG or with exercise induced. Medical conditions such as Diabetes, Sarcoidosis, and Hyperthyroidism can increase the arrhythmia risks.

Ultrasound maybe used to create images of the heart. It will allow a technician to take picture of your heart pumping blood. MRI study may also create detailed images of the heart or an angiogram while the scan will create an image of your arteries. The Holter monitor or an ambulatory telemetry device may record simultaneously the heart rhythm in surveillance for one or two weeks. His device is the size of a smartphone and can be held around your neck or in your pocket or simply attached to your belt, recording the function of the heart. Other signs like palpitations, headaches, lightheadedness can also be experienced. Some devices will record changes in the heart rhythms.

Genetics have been suspected in rhythm disorders and sometimes, genetic testing may be suggested with blood and stress testing as well as advanced imaging. Your cardiologist may discuss the issue with you because AF affects millions of people worldwide and if left untreated, it increases the risk and severity of stroke, heart failure and death.

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### References:

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