What are arrhythmias?

- **The heart's electrical system**
  
  An internal electrical system inside the heart controls the rate and rhythm of the heartbeat. At each beat, an electrical signal goes through the heart causing the heart muscle contraction. Each electrical signal begins in a group of cells called the sinoatrial node (SA), situated in the right atrium, the right upper cavity of the heart. From the SA node, the electrical signal travels along specific pathways in the right and left atria, leading to its contraction and therefore allowing the passage of blood in the ventricles, the two lower chambers of the heart. The electrical signal then comes to another group of cells, referred to as the atrioventricular node (AV), placed right in the center between the atria and ventricles. Here, the electrical signal slows down a bit its course, allowing the ventricles to fill with blood. Leaving the AV node, the electrical signal continues to travel along a path called the bundle of His, that at some point is divided into a right and a left bundle branch. The signal goes down along the two branches to the ventricles, leading to its contraction and therefore the spread of blood to the lungs (right ventricle) and to the rest of the body (left ventricle). At this point the ventricles relax, and the process of the heartbeat starts over again with the production of a new signal 60-100 times per minute.

- **Arrhythmias**
  
  Any alteration in any point or level of the electrical process of production of the heartbeat is called arrhythmia. An arrhythmia is an abnormality in the rate or rhythm of the heartbeat, in which the heart can beat too fast, too slow or with an irregular rhythm. The too fast heart beat (over 100 beats per minute) is called tachycardia, when the pulse is too slow (less than 60 beats per minute) is called bradycardia. We different types of arrhythmias, depending on the involved location and the type of electrical anomalies. Arrhythmias can be divided into hyperkinetic arrhythmias (supraventricular and ventricular) and hypokinetic ones.

**HYPERKINETIC ARRHYTHMIAS:**

1) **Supraventricular arrhythmias**

- **Extrasystoles**
  
  They are caused by a premature contraction. They can give the classic feel of the "missing heartbeat" or the "flickering" or brief episodes of palpitations. Typically the extrasystoles are not dangerous and asymptomatic forms are frequent.

- **Tachyarrhythmias**

  - **Atrial fibrillation (AF)**
    
    It is the most common type of supraventricular arrhythmia, affecting more than 5% of the population above 70 years of age and 10% over 80 years. The electrical signal begins not in the SA node but at different points of the right atrium and left atrium and in pulmonary veins. Instead of following the usual path, the signal spreads through the atria in a fast (even up to 300 pulses per minute) and disorganized way. This results in a very fast contraction (fibrillation) of the atrial wall and a transmission of the pulse with a variable frequency and a consequent irregular heartbeat. Usually the AF does not endanger the patient’s life, but it can become worrying when the electrical anomaly spreads to the ventricles, causing them to beat too fast. Atrial fibrillation is divided into paroxysmal (spontaneous regression), persistent (when the restoration of sinus rhythm is achieved with medications or electrical cardioversion), permanent (when it is already resistant to all therapies and has become chronic). The main complication of AF is stroke, and to avoid this problem therapy with anticoagulants is needed.

    - **Atrial Flutter**
      
      It's a condition similar to AF, with the difference that signal instead of spreading in a chaotic way through the atria moves like a circular wave in a quick and regular way. It’s less common than AF, it may sometimes precede it, and has the same symptoms and the same complications. It is divided into common, atypical and left atrial flutter.

    - **Nodal reciprocating tachycardia (NRT)**
      
      Due to the presence of a slow pathway conduction in AV node it begins and ends abruptly and is of variable duration. It's a type of arrhythmia not usually dangerous, typical of youth and especially of the female (7 to 1).

    - **Wolff-Parkinson-White (WPW) Syndrome**
      
      It is a re-entrant atrio-ventricular tachycardia in which the electrical signal travels from the atria to the ventricles on a different pathway.
compared to the usual one. It is characterized, in manifest forms, for the presence of delta wave in electrocardiogram. It's 'one of the most dangerous forms of arrhythmia.

2) **Ventricular arrhythmias**

- **Ventricular extrasystoles**
  Occur at the level of the ventricles. Take the name of premature ventricular contractions (PVCs). If they present as single or in pairs and are not associated with heart disease have the same importance as supraventricular extrasystoles.

- **Ventricular tachycardia**
  It's a fast and regular heartbeat of ventricles, it may last from a few seconds or longer. A few beats of ventricular tachycardia does not usually cause problems. More prolonged episodes can be rather dangerous, they can turn in more severe forms of arrhythmia such as ventricular fibrillation.

- **Ventricular fibrillation (v-flb)**
  Occurs when disorganized electrical signals make the ventricles, instead of beating normally, to tremble and shake. The consequence is that the ventricles are no longer able to pump blood through the body. Within seconds you become unconscious and, in the absence of timely intervention of electric shock to the heart or defibrillation, death occurs within minutes. Most sudden cardiac deaths are due to v-flb.
  A particular form of v-flb is the **torsades de pointes** (literally "twisting of the points") syndrome, a condition which determines a very specific electrocardiographic profile and which can be triggered by the assumption of certain drugs or by the presence in the blood stream of imbalanced amount of potassium, calcium or magnesium.

  Particularly at risk for torsades are the individuals who have the so-called long QT syndrome, a particular cardiac electrical abnormality. These people need to pay attention in taking antibiotics, cardiac drugs or drugs not prescribed by doctor.

**HYPOKINETIC ARRHYTHMIAS**

- **Sinus Node Dysfunction (SND)**
  In this arrhythmia the heart rate is slower than normal. If it is too slow, the brain cannot be reached by a sufficient amount of blood and this causes dyspnea and asthenia for minimum effort.

- **Atrioventricular blocks (AV blocks)**
  May be I, II and III level depending on the severity and the block in the impulse when it passes through the atrioventricular node. In more severe cases can cause syncope and cardiac arrest.

What are the causes?

Arrhythmia occurs when we have a delay or block in the electrical signals that control the heartbeat. This occurs when special nerve cells that produce electrical signals do not work properly or if the signal does not normally travel through the heart. An arrhythmia can also occur following the production within the heart of an electrical signal added to the signal produced by nerve cells devoted to this work.

Factors favoring arrhythmias are smoking, alcohol abuse, the use of drugs such as cocaine or amphetamines, caffeine or nicotine in excessive amounts, side effects of some drugs, digestive disorders, COPD. Other causes may include a significant emotional stress or anger, which can induce an increase in heart rate, increased blood pressure or release of specific stress hormones, all factors that can favor, in some people, an arrhythmia.

Important factors are cardiac infarction or previous medical conditions such as hypertension, coronary heart disease, thyroid disorders, that lead to overproduction or underproduction of thyroid hormone, rheumatic heart disease.

In some forms of arrhythmia, such as the WPW syndrome, we found factors linked to congenital cardiac malfunction, or present from birth.

In other cases, the cause is unknown.

What are the symptoms?

Many arrhythmias do not produce any signs or symptoms. When present, the most common symptoms are:

- Palpitations, related to feelings as if the heart loses a beat, as if trembling or beating too hard or fast
- Slow heartbeat
- Irregular heartbeat
- Feeling of missing a beat
- Flickering

The more serious symptoms include:

- Anxiety
- Weakness, dizziness, lightheadedness
- Fainting or to be on the verge of fainting
- Sweating
- Shortness of breath
- Chest pain

What are the treatments?

Arrhythmias need to be treated in the presence of important symptoms such as dizziness, chest pain, fainting, or when it increases the
risk of complications such as cardiac arrest or stroke. The common forms of treatment include drug therapy and surgical procedures.

- **Drug Treatments**

Drugs are usually used to speed up or slow down the heartbeat and to convert an abnormal heart rhythm in a normal and stable rhythm (antiarrhythmics drugs).

Among the drugs that slow the heart rate we have the major beta-blockers (metoprolol, bisoprolol, carvedilol, sotalol or atenolol) and calcium channel blockers (such as diltiazem or verapamil), sometimes used in the treatment of atrial fibrillation. Among the drugs that control heart rhythm we can cite amiodarone, sotalol, flecainide, propafenone. These are drugs that should be assayed by an arrhythmias specialist because of their side effects. In atrial fibrillation, except where contraindications are present, drugs commonly used are anticoagulants, or blood thinners, in order to prevent the formation of blood clots. Among the anticoagulants we cite acenocoumarol, warfarin, heparin.

- **Surgical Procedures**

Pacemaker is the non-drug treatment of hypokinetic arrhythmias. It is a small tool that is placed under the skin in the chest area in order to control the heart rhythm via direct electrical pulses to the heart. Following then plant each patient can have the pacemaker programmed to suit his needs.

Defibrillator (ICD is the planted tool when the patient presents ventricular arrhythmias we have to treat not only pharmacologically. In addition to the normal functions of a stimulator this tool, a little larger than a pacemaker, is able to recognize and treat with an electrical shock arrhythmias dangerous for the heart. Other forms of treatment may send an electric shock to the heart: electrical cardioversion (atrial fibrillation or flutter) or defibrillation (for ventricular arrhythmias). In many types of arrhythmia (NRT, WPW, atrial flutter and fibrillation, ventricular tachycardia) a procedure is used known as radiofrequency catheter ablation. In this procedure, a long, thin and flexible catheter is introduced into the femoral vein at the groin, and from here, guided to the heart, where we the sites responsible for arrhythmia are identified and destroyed by the application of RF energy.

- **Surgery**

The use of surgery usually happens when a surgical procedure has already been performed for another reason, such as the repair of a heart valve.

In atrial fibrillation a particular surgical technique is used called "maze", in which the surgeon makes small cuts or burns to the atria in order to prevent as far as possible the spread of electrical disorganized signals. If the arrhythmia is caused by coronary heart disease, may be recommended the insertion of a coronary artery bypass grafting (CABG), able to improve blood flow to the heart muscle.

What is the prognosis?

The kaleidoscope "arrhythmias" encompasses several clinical conditions with different levels of danger for the patient. They range from relatively harmless forms such as extrasystoles, to more serious forms such as some supraventricular arrhythmias to forms that put lives at risk, such as ventricular fibrillation.

What about the AFaR research? (by dr. Fabrizio Sgreccia)

In our hospital (Tiber Island, ed) we have a 25 years tradition in the field of electrostimulation (pacemaker and defibrillator). In the last decade this method has been joined by electrophysiology (electrophysiologic studies and radiofrequency catheter ablation). We are participating in a project of cardiac monitoring for remote control of implanted devices (pacemakers and defibrillators) in order to make more timely and appropriate medical intervention and minimize access to hospital, resulting in lower costs for patients, reduced waiting lists and cost savings for the NHS. Our current areas of research include the echocardiographic assessment of patients with dilated cardiomyopathy and heart failure to be subjected to biventricular pacing, modulation of heart rate by vagal stimulation via endocardial catheter placement, ablation of atrial fibrillation.