Module – 03

Lecture - 14

Okay, so you and then in the last one in what we have seen in the last module we have seen how to perform ECG experiment, right? It's a long model so I hope you guys were able to stick to your chair and look at it because it's, it's not so easy to show online, how to perform ECG actually how to take the signals from the ECG electrodes and do the signal conditioning circuit in real time right, so we have tried our best to show It to you how it can be done by using different signal conditioning circuits. Now when you talk about ECG, now you also know, that the there is the, the lot of you know different variation of heart disease are there one of them is Atrial fibrillation.

Now when you talk about fibrillation and a Atrial fibrillation it's a beating of irregular bits hard bits and actually that happens because of the misfiring of signals. So you see when the heartbeat suddenly faster right, that is one of the arrhythmia but when it beats abnormally is fast slows down again fast right, so it's not a rhythmic way of beating, then it's called arrhythmia.

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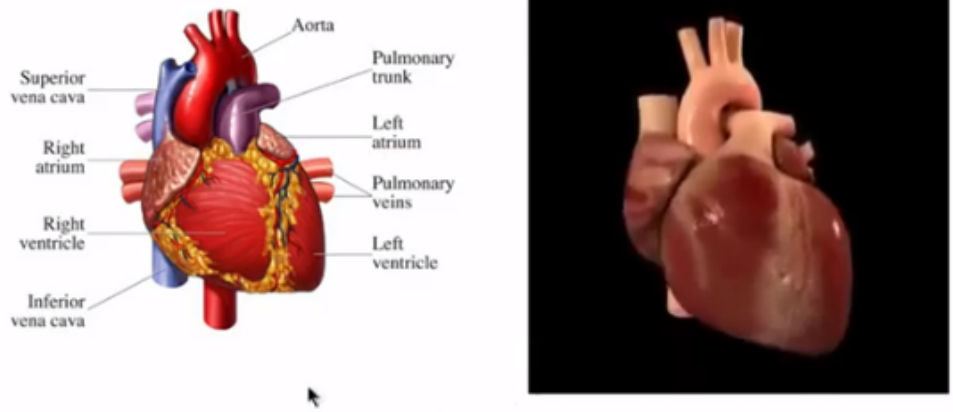

And if you see the, the heart right, is how the, how we have done this particular you know the physiology, Where we have inferior vena cava, we have ventricles, left ventricle, right ventricle right atrium, left atrium, the pulmonary trunk, Aorta, superior vena cava right but, but as you can see here this is how the actual heart looks like right. So the heart that you draw and then heart rate, you see it's very different okay, so this is a real heart and then you can see their Purkinje fibers right and the this is the this is like extremely important organ, right and and the moment it starts submitting abnormally there are a lot of you know, a lot of thing happens one of the, one of the problem is a clotting of blood right. So what is what exactly this atrial fibrillation is and how it can be cured now why we are talking about defibrillation how can be sure because we have just seen about the ECG measurement?

So that that ECG signal can help us to understand that the person is suffering from Atrial fibrillation right, and that's why I am showing you this particular slides to, to help you out that what exactly is a Atrial fibrillation and what are how it is cured and what kind of electronic system, we can design integrating the op amp component and also how to design sensor, that can help to make the surgery better alright, so that is our idea.

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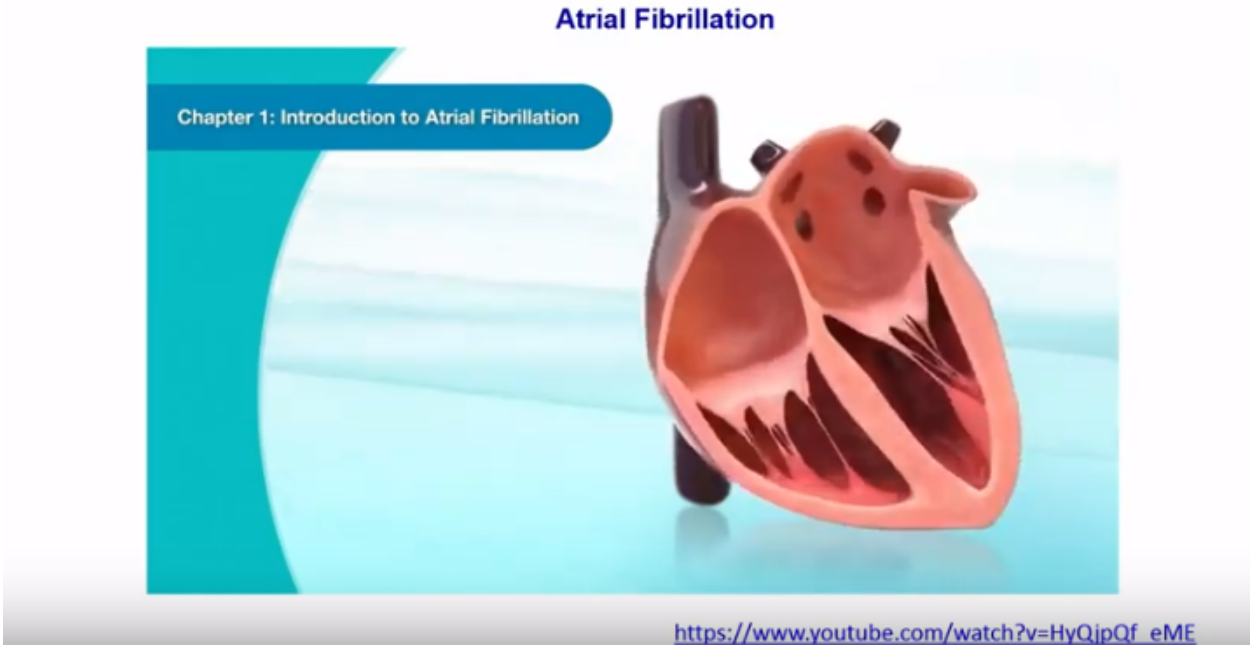

So if you see this slide, I'll play the Atrial fibrillation, so that you can understand what actually we are talking about Atrial fibrillation, Afib is a heart condition ,that causes the heart to race and beat in an irregular rhythm people often say , that when they have an episode of a fib.

They feel as though a fish is flopping around in their chest or that their heart feels like it. Will explode Afib can increase your risk of heart failure stroke and even death because of these risks and because Afib can get worse over time. It is important to have it diagnosed early and cared for appropriately Afib is the most common type of irregular heartbeat or arrhythmia, it affects over 2.5 million people in the United States alone. Your heart is a muscle that acts like a pump, with each beat it squeezes or contracts to push blood to the rest of your body.

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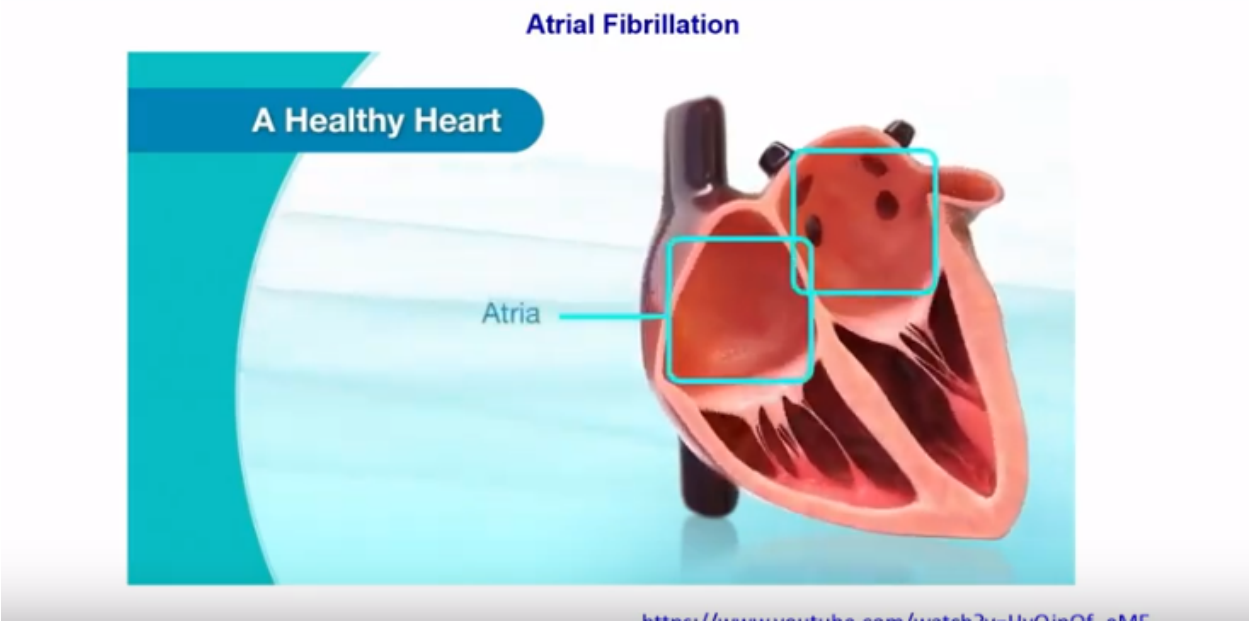

Your heart has four chambers the two upper chambers are called Atrial.

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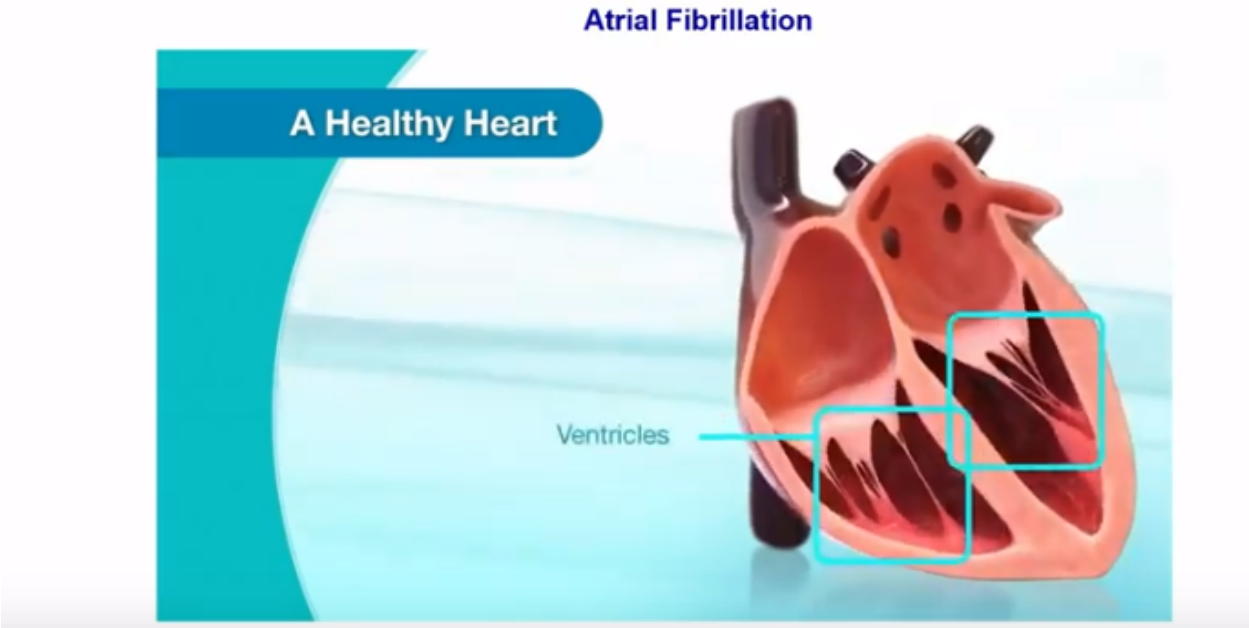

The two lower chambers are called ventricles under normal conditions the upper and lower chambers of the heart work together to pump blood throughout the body. The blood stream enters the atrium, where blood is pumped to the ventricles in a regular and cord way, from their blood is pumped from the ventricles to various parts of the body, the healthy heart beats in a regular steady rhythm or pattern, notice how the heart beats evenly and uniformly.

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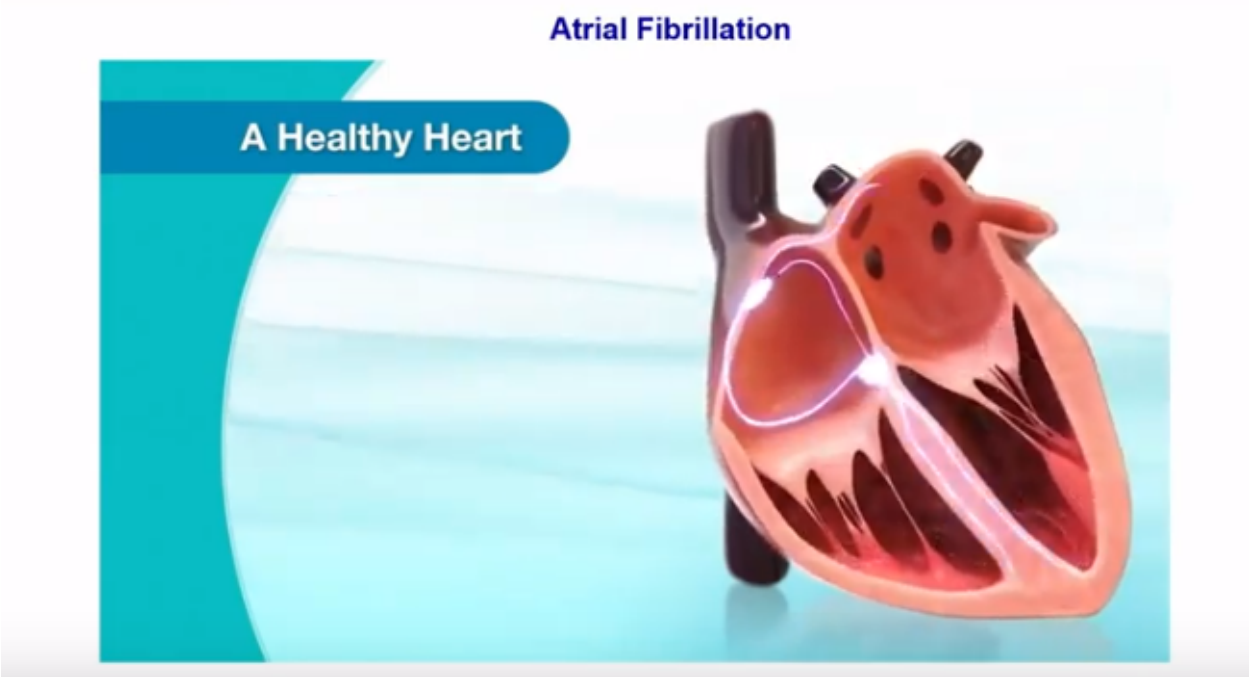

In a healthy heart electrical signals travel through the heart in a regular pattern as seen here. these electrical impulses originate in a special section of the atrium and travel through , the heart in a regular pattern each signal ultimately causes ,the heart to beat an A fib the top two chambers of the heart or Atrial beat very fast and in an irregular pattern ,that is out of rhythm. Notice how the Atrial appear to quiver and are uncoordinated, due to this irregular pattern, the Atrial do not coordinate with the ventricles and the heart is out of rhythm. A fib occurs when electrical signals start in the wrong place and misfire. The faulty signals cause, the Atrial to quiver and not contracts completely notice, how the signals spread in a rapid disorganized way.

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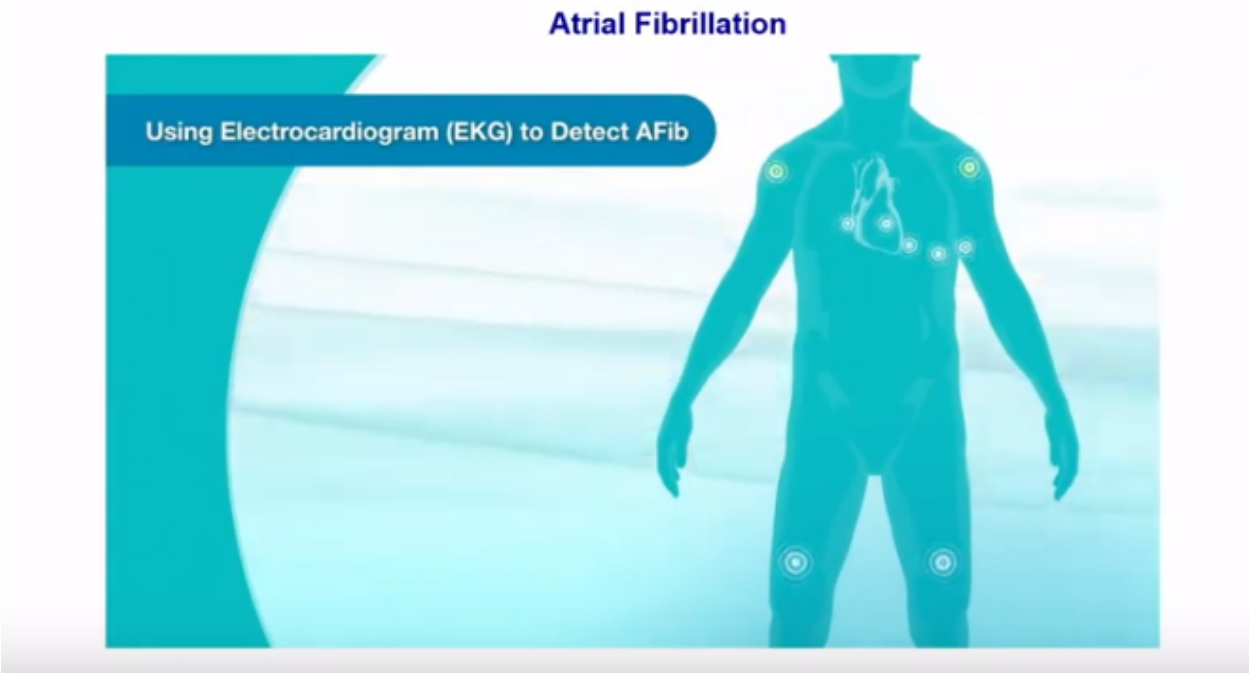

Your doctor may perform a test called an electrocardiogram or an EKG, to see your heart's electrical activity and rhythm during an EKG; small electrodes are placed on specific parts of your arms, chest and legs, using small stickers.

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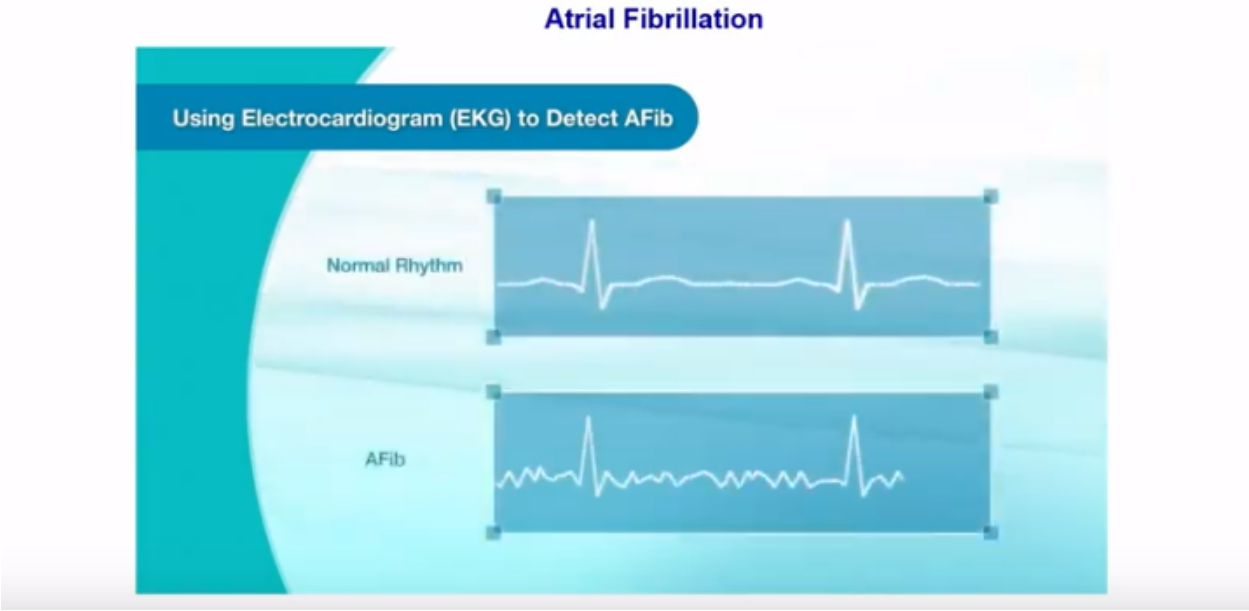

When the heart beats the electrode sends signals to the EKG machine, the EKG measures the electrical impulses or waves Shown here as lines, see the differences between a healthy heart and a heart and a fib.

In a normal heartbeats are evenly spaced and show a regular pattern, in Afib the waves appear more chaotic and random.

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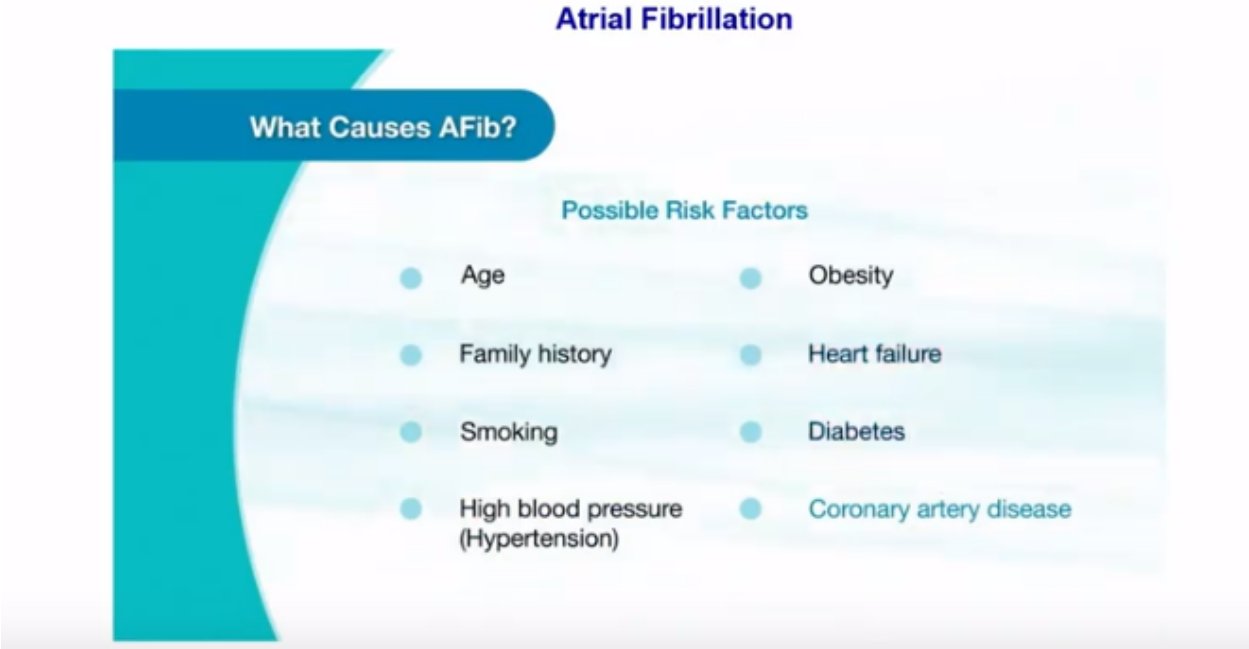

While the causes of Afib are often unknown, there are a number of things that increase the chances you might get it. some of these, include age, family history, smoking, high blood pressure or hypertension and obesity, also if you have any of the following conditions, you're more at risk of Afib heart failure diet or coronary artery disease the more of these risk factors, you have the more likely it is you might experience A fib. Be sure to discuss your full medical history with your healthcare provider.

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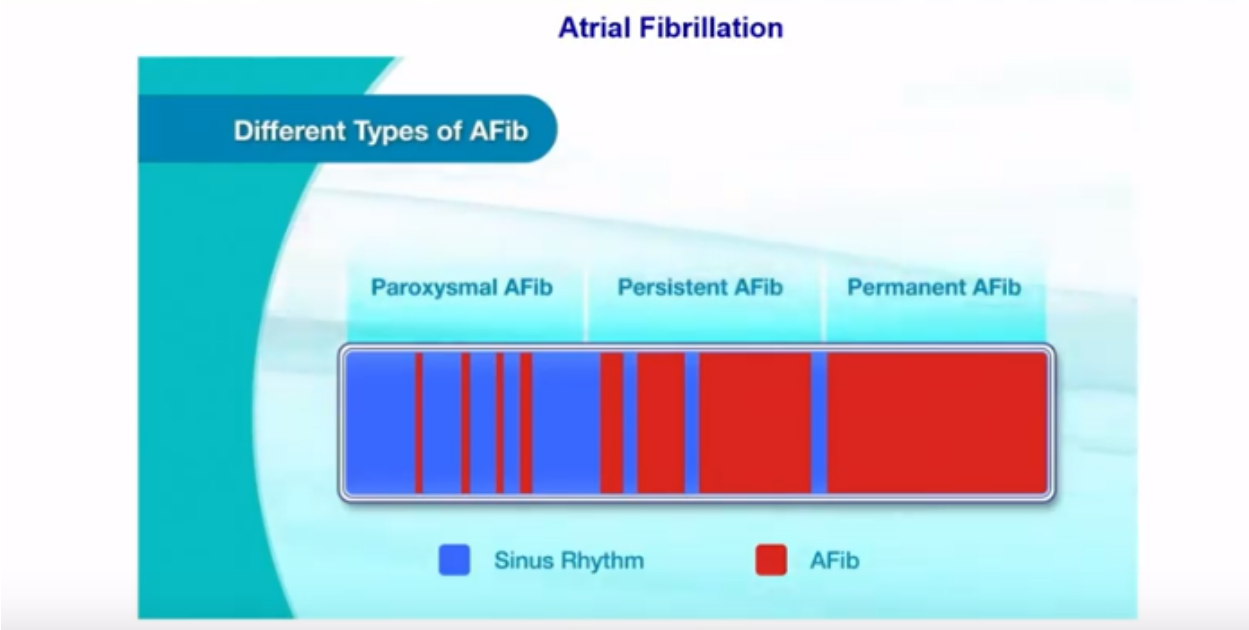

Afib Often gets worse as time goes on. It’s important to take care of it early, because the longer your heartbeat is out of rhythm, the harder it is to return to normal. In this chart the red lines represent Afib episodes and the blue lines represent times when the heart is in rhythm. When many patients are first diagnosed they experience periods of a fib that may come and gone. These episodes may be momentary or last for days but generally go away on their own. This is called paroxysmal Afib. In some situations Afib may not go away, on its own. Your doctor may need to perform a procedure or provide medicine for a cardio version to bring your heart back to normal rhythm. This is called persistent, Afib and some people who have had Afib for a long time, the heart may not be able to return to a normal rhythm at all. this is called permanent Afib, notice That over time the red areas are larger and more frequent , this is why it's important to talk to your health care provider to be sure that you're doing all you can to keep your heart and rhythm.

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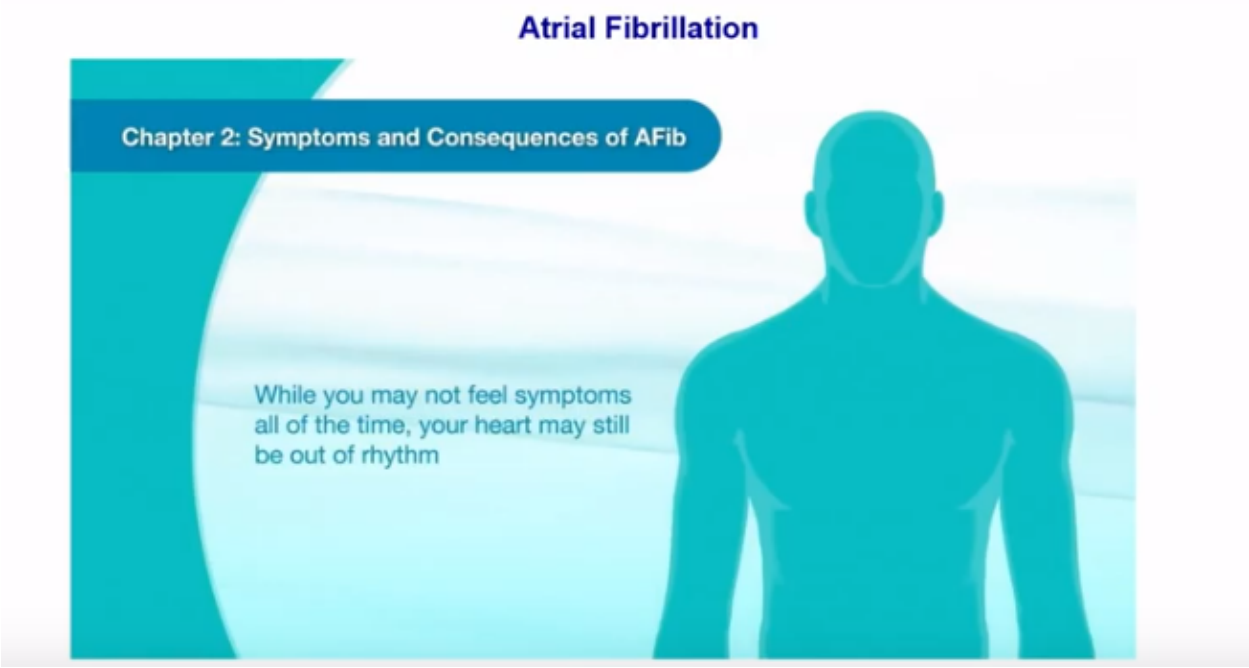

There are many signs and symptoms of Afib many describe an uneven flopping or racing heartbeat. A fib can make you feel light-headed, dizzy or even short of breath. Some people feel tired or weak, others experience chest pain or discomfort such as palpitations, these symptoms might be subtle or severe and they may come and go and you may not experience any symptoms at all. In fact 60% of patients don't even know when they're having an Afib episode. If you have Afib, it's important to know that while you may not feel symptoms all of the time your heart may still be out of rhythm and you're still at risk for other complications like remodeling or stroke.

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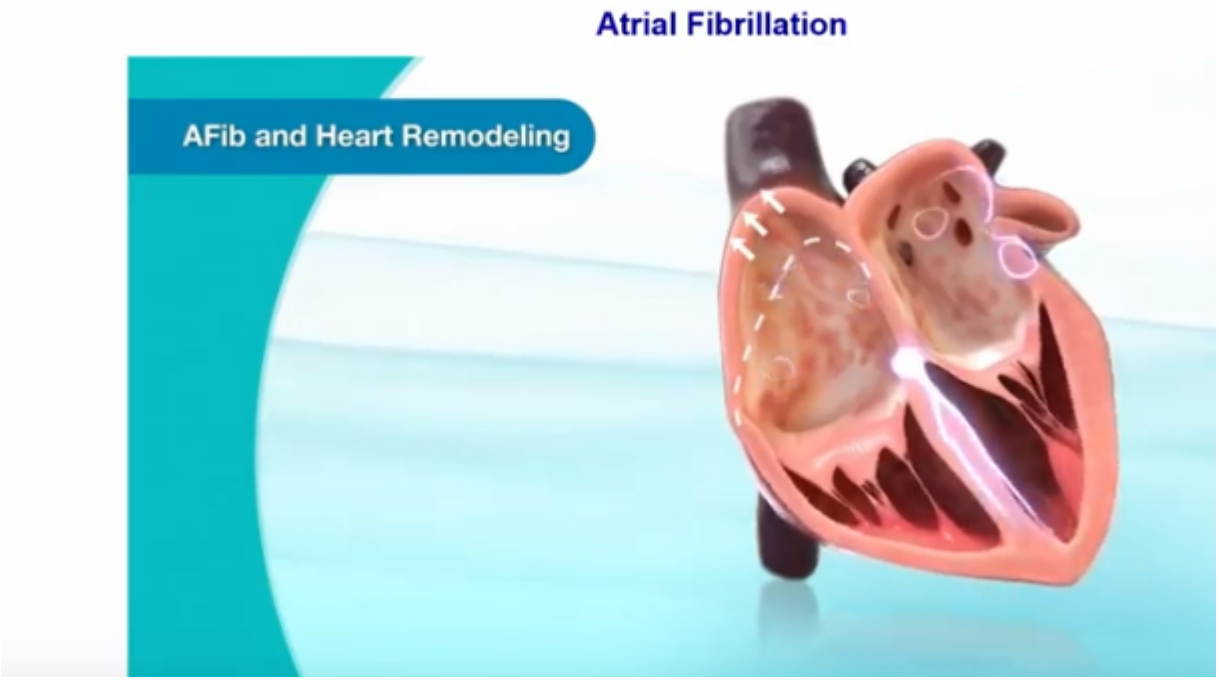

if left untreated Afib can change the size and even the shape of your heart through a process called remodeling , remodeling can cause permanent changes in your heart in a very short amount of time potentially, just a few days, because of Afib your heart has to work much harder and hard tissue Can be damaged, notice how the heart increases in size and its walls thicken even , if you 'recurrently being treated for Afib it's important to understand if your management program is addressing all the risks associated with the disease.

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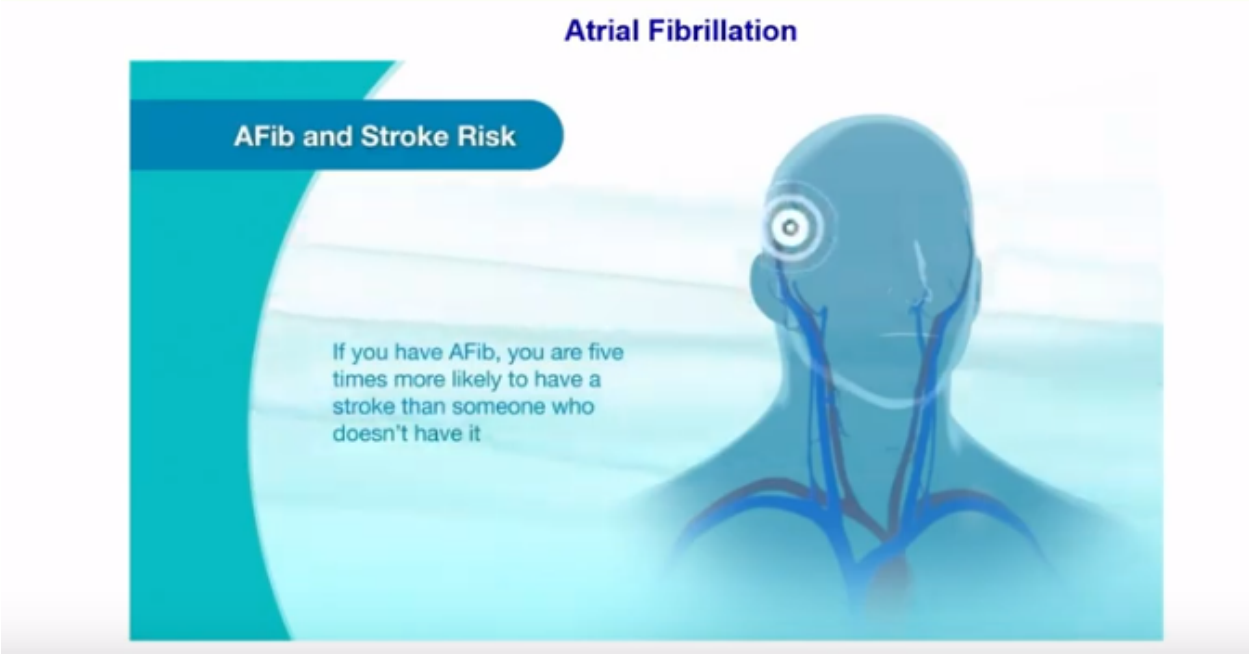

During fib blood can collect or pool in your heart and cause a clot to form. If this happens the clot can travel from the heart to the brain and cause a stroke, if you have Afib you're five times more likely, to have a stroke than someone who doesn't have it it's important to talk to your health care provider about your risk of stroke and how to reduce it.

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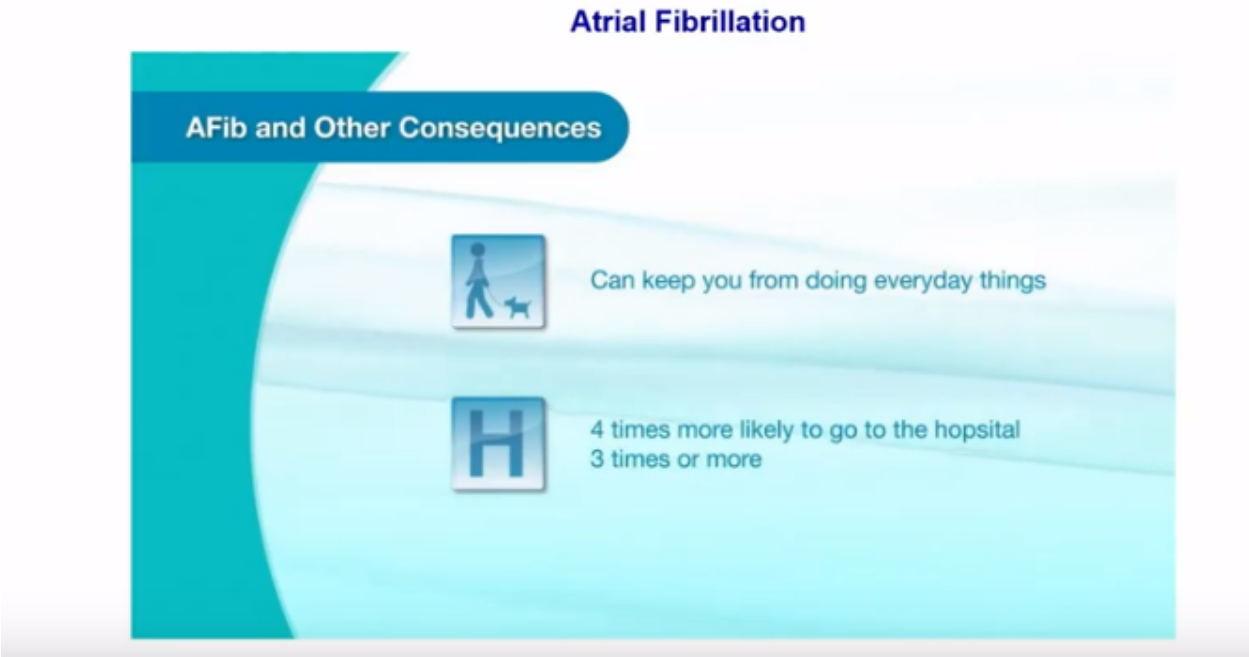

You may feel exhausted and weak as a result of your heart not pumping properly. While some people with Afib may be able to lead a normal lifestyle. In some cases having Afib can keep you from enjoying exercise and everyday activities.

If you have Afib you're four times more likely to end up in the hospital three or more times, than those who don't have the disease, it's important that you continue to talk to your doctor about managing your Afib even, if you are not currently experiencing symptoms.

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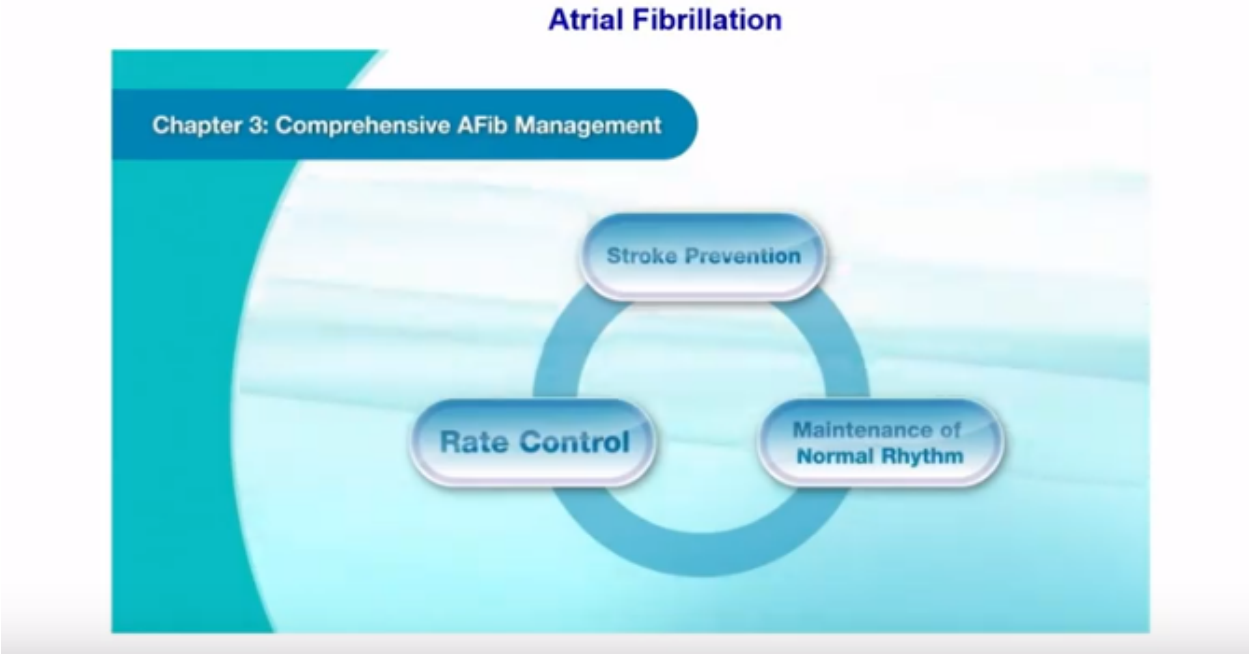

The Afib treatment guidelines for health care providers recommend a comprehensive approach to treating all the risks of Afib. the guidelines prioritize, three treatment goals, rate control maintenance of normal rhythm and stroke prevention health care providers May provide a range of treatments to jointly manage the different risks and symptoms of A fib.

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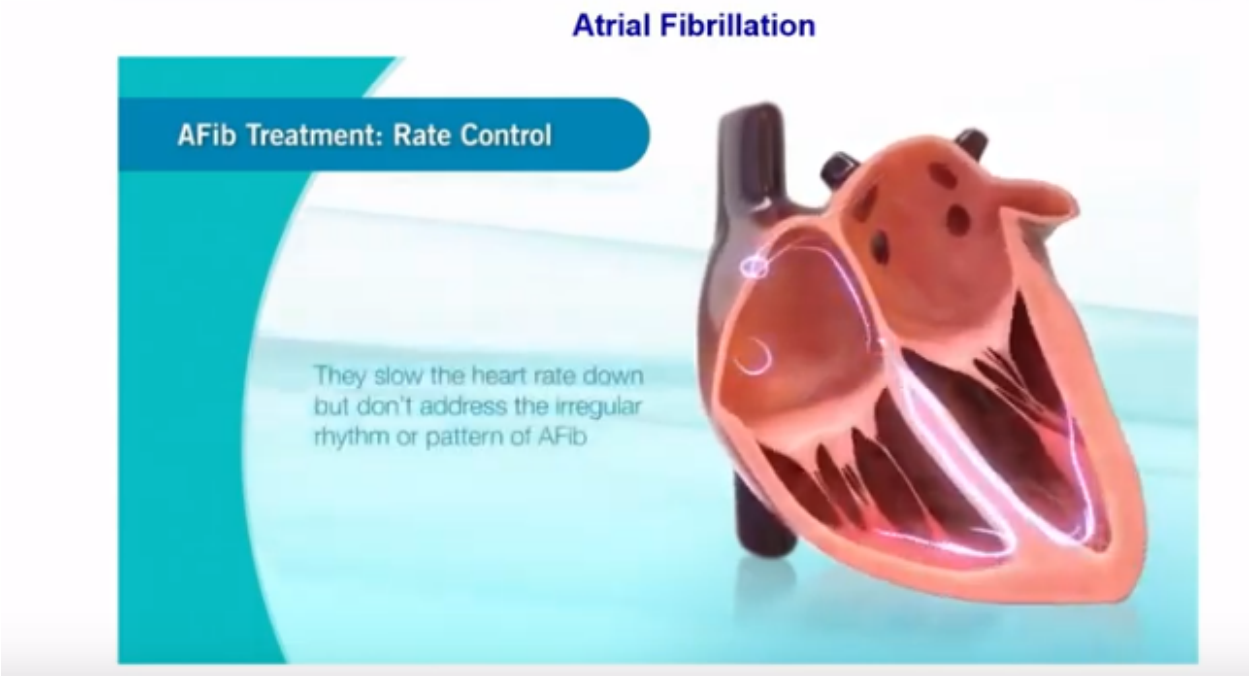

There are a number of ways that Afib is treated; your doctor may prescribe a medication to slow down the pace or rate at which your heart beats. Notice that the rate medication slowdown the heart rate. However, the heart continues beat irregularly and out of rhythm. Rate control medications do not correct the irregular heart rhythm associated with fib.
They slow the heart rate down, but don't address the irregular rhythm or pattern of a fib.

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Your doctor may recommend a treatment designed to more specifically address the rhythm of your heart. When rhythm control medication issued the heart beats in normal rhythm, but remains fast rhythm treatment regulates your heart rhythm. But may have little or no effect on the rate at which your heart beats. Combination of rate and rhythm control treatments may be recommended to reduce the heart rate and maintain the normal heart rhythm rate control medication is used to slow the heart rate down. When rhythm control is added the goal is to have the heart beat at a normal rhythm.

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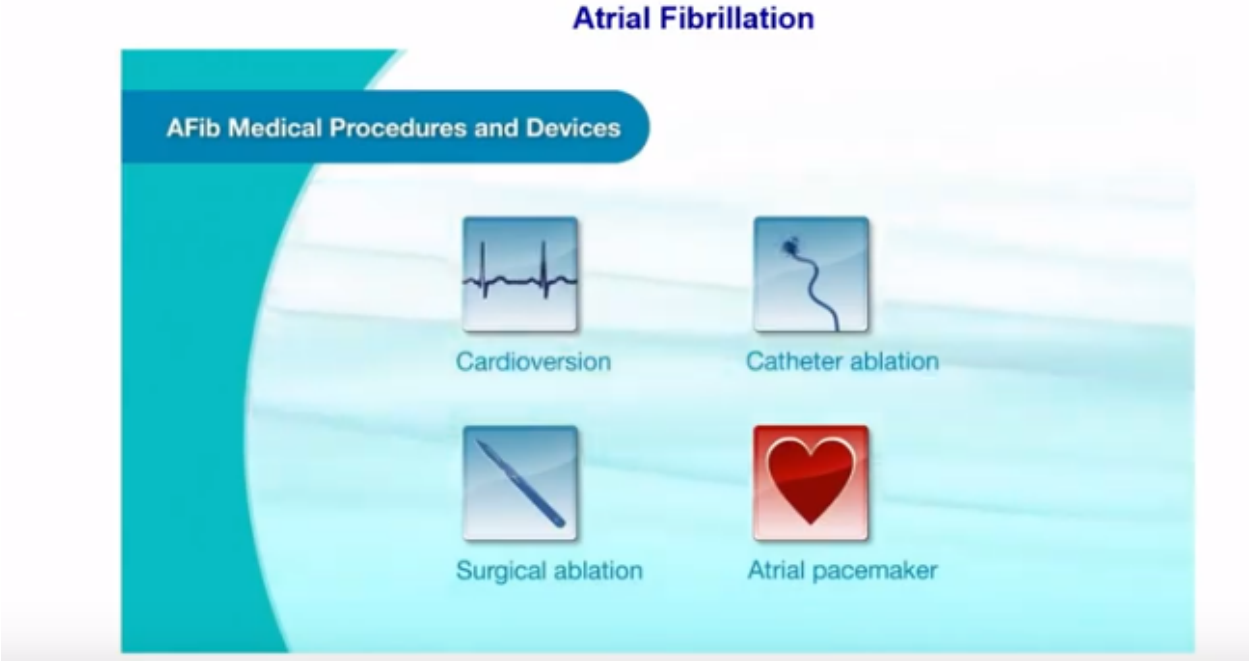

Other treatments for fib may include surgical and on-surgical procedures and implanted devices. If medicine has not been effective, your doctor may perform a procedure called a cardio version, in which electrical current is used to restore a normal heart rhythm. Radiofrequency ablation, sometimes called catheter ablation is a procedure

That stops the heart from setting off the faulty electrical signals that cause the chaotic heartbeats of A fib. Surgical ablation is a surgical procedure to destroy the cells causing abnormal heart rhythm. It may be used when other treatments have not worked. The surgeon treats, the surface of the heart directly rather than relying on catheters and x-rays to reach the heart. For some patients a small battery-powered device called an Atrial pacemaker May be implanted under the skin to generate electrical signals to regulate heartbeat.

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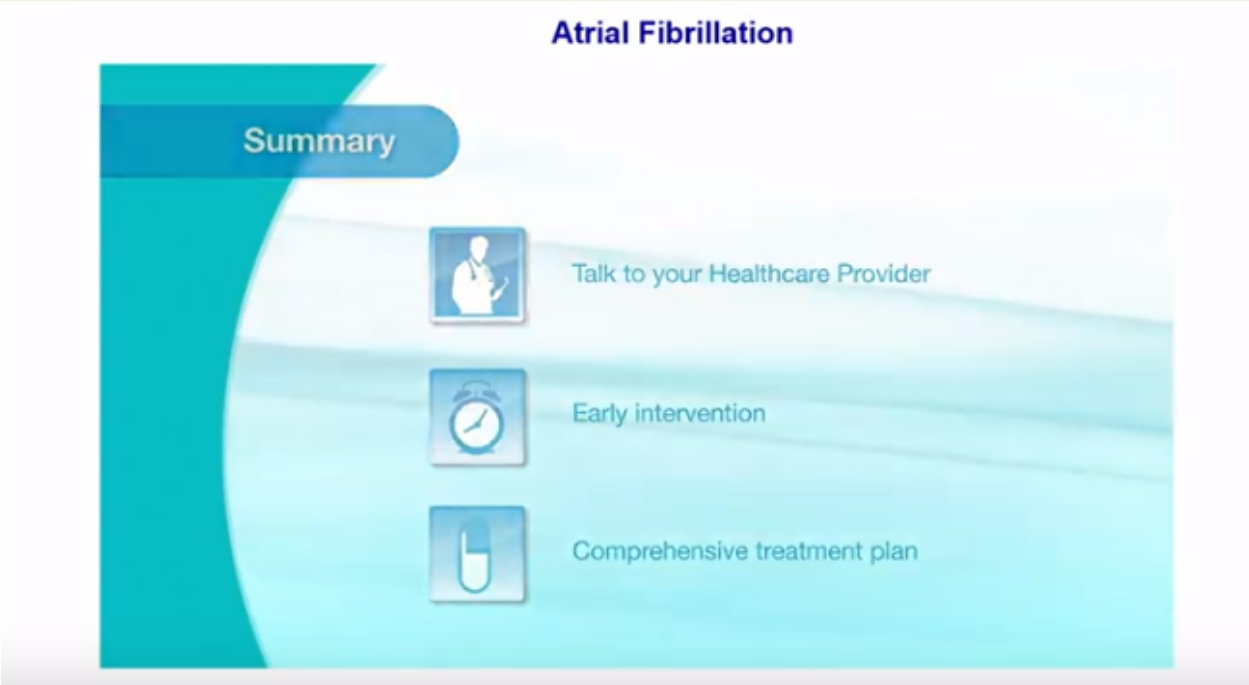

Talk with your healthcare provider about; which treatment options are best for you. Whichever plan you decide on it's important to remember that, A fib is a progressive disease the longer you wait to restore your normal heartbeat.

The more difficult it is for your heart to return to a normal rhythm, finally, keep in mind that a comprehensives approach to treating all the risks of a fib is important, brought to you by SANOFI.
Now when you talk about atrial fibrillation, also let us see that in turf ablation is, what we have seen in the video right but to cure it what, what suddenly surgeon has to do? He has to insert the catheter and then he has to burn this tissue, this is a hard tissue assume that this is a heart issue and we had to burn the tissue because the misfiring of the signal happens in this particular region. So you, you have to burn this tissue, burning of these tissues called ablation, burning of tissue is called ablation. Now because we are using a tool called catheter, right which is Avery thin tube and we are heating or burning the tissue it is called catheter ablation.

Now within catheter ablation also there is a cry ablation and then there is a RF frequency that is used to heat or burn the tissue cry is cold so let us see, how the catheter ablation is performed through this video and then were move the next slide.

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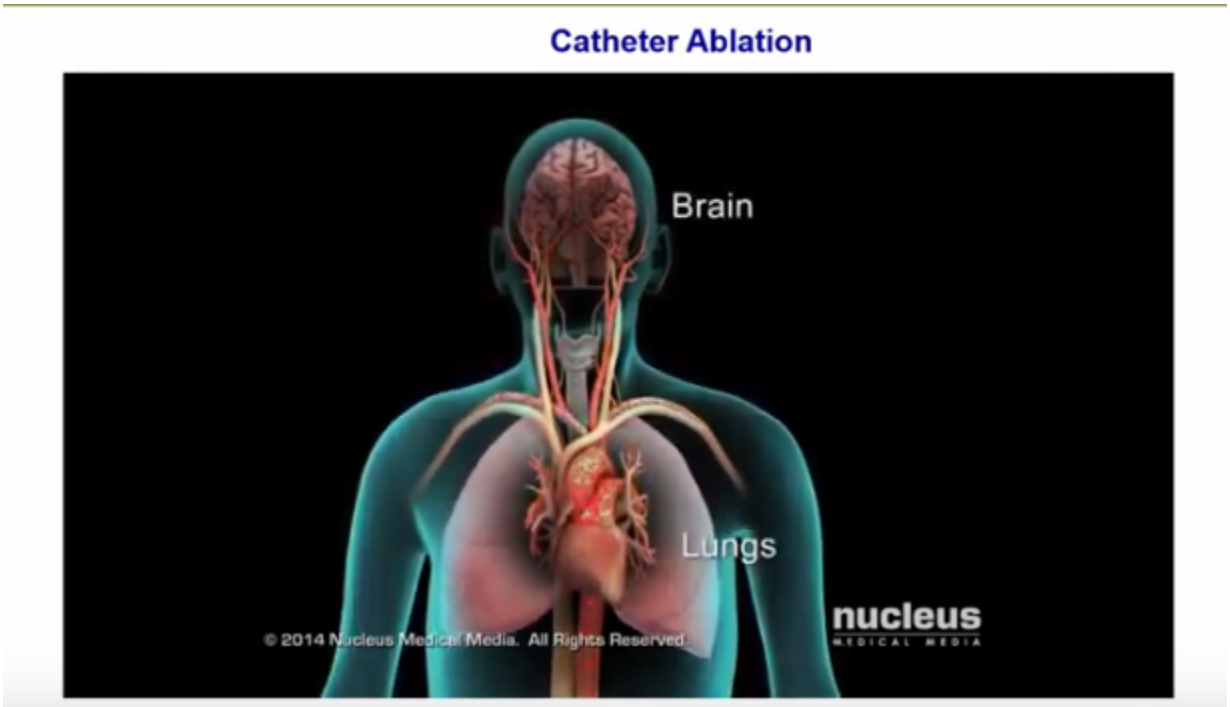

Depending on activity level the heart beats, about 60to 100 times per minute, it may be higher during exercise or lower at rest. a normal heart rate and rhythm ensures the delivery of oxygen-rich blood to all of the body's organs, such as the brain and lungs.

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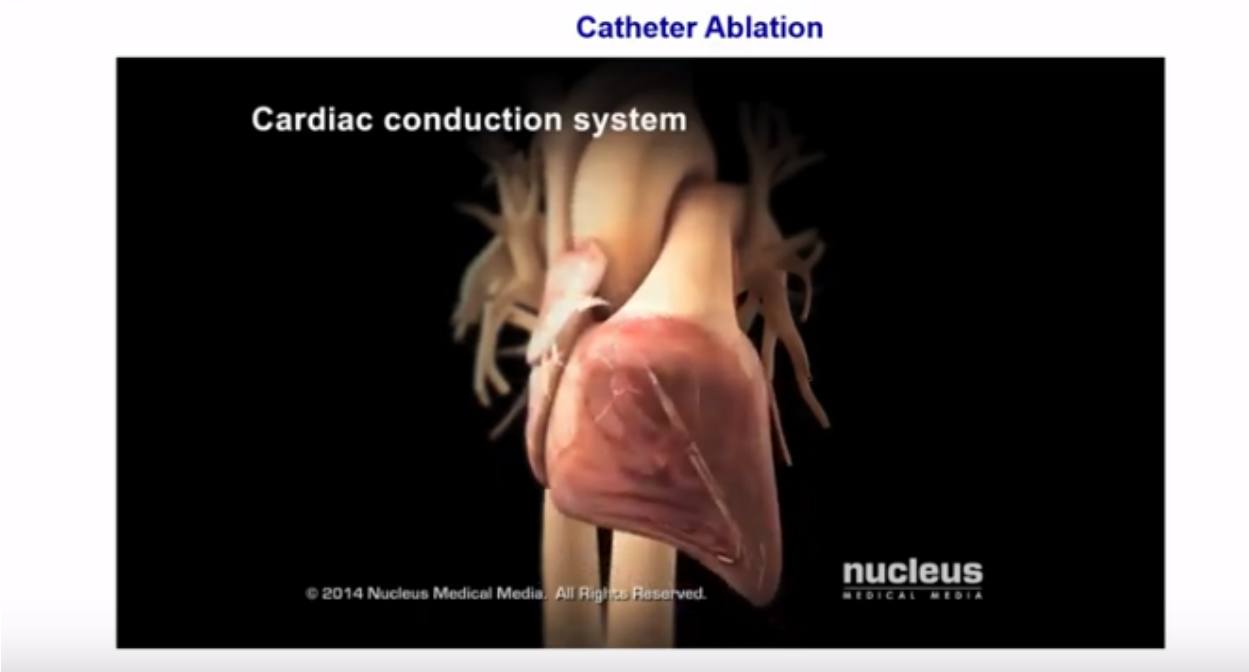

a group of cells in the heart called the cardiac conduction system, uses electrical impulses to control the speed and rhythm of each heartbeat.

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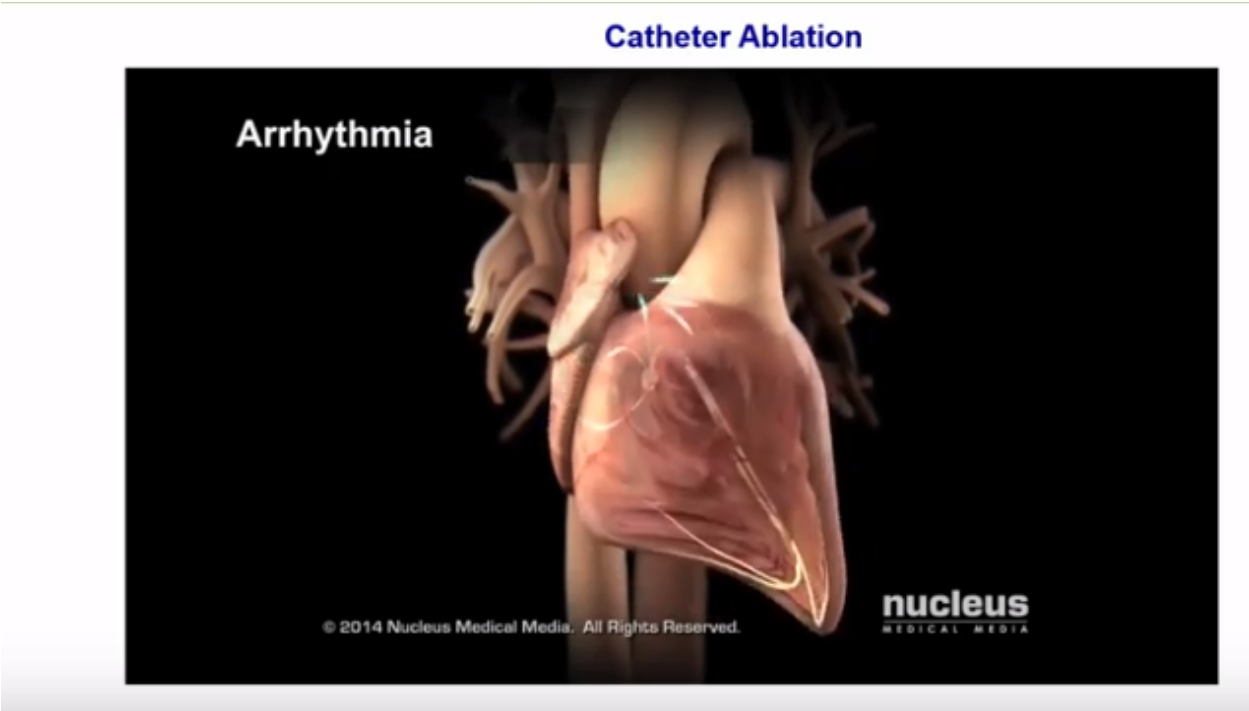

An abnormal heart rate or rhythm called an arrhythmia occurs when there's a problem with the heart's conduction system.

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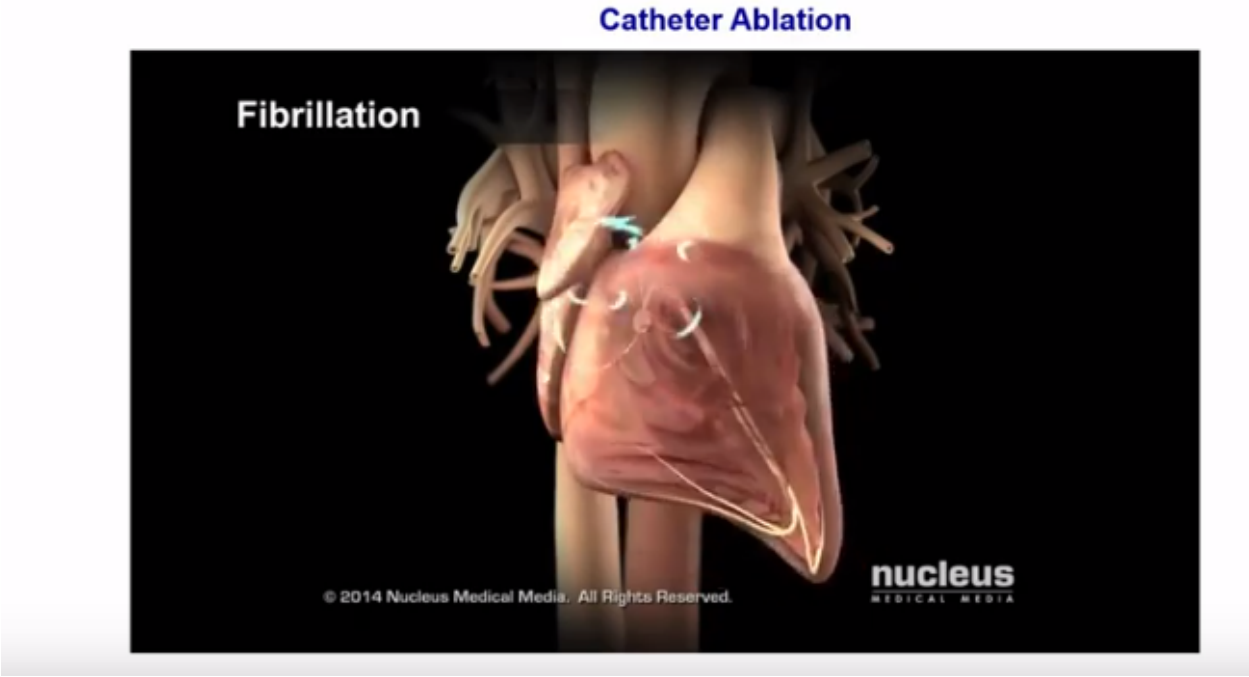

Tachycardia is a type of arrhythmia where the heart beats too fast fibrillation as a type of arrhythmia, where the heart beats irregularly and may be too fast.

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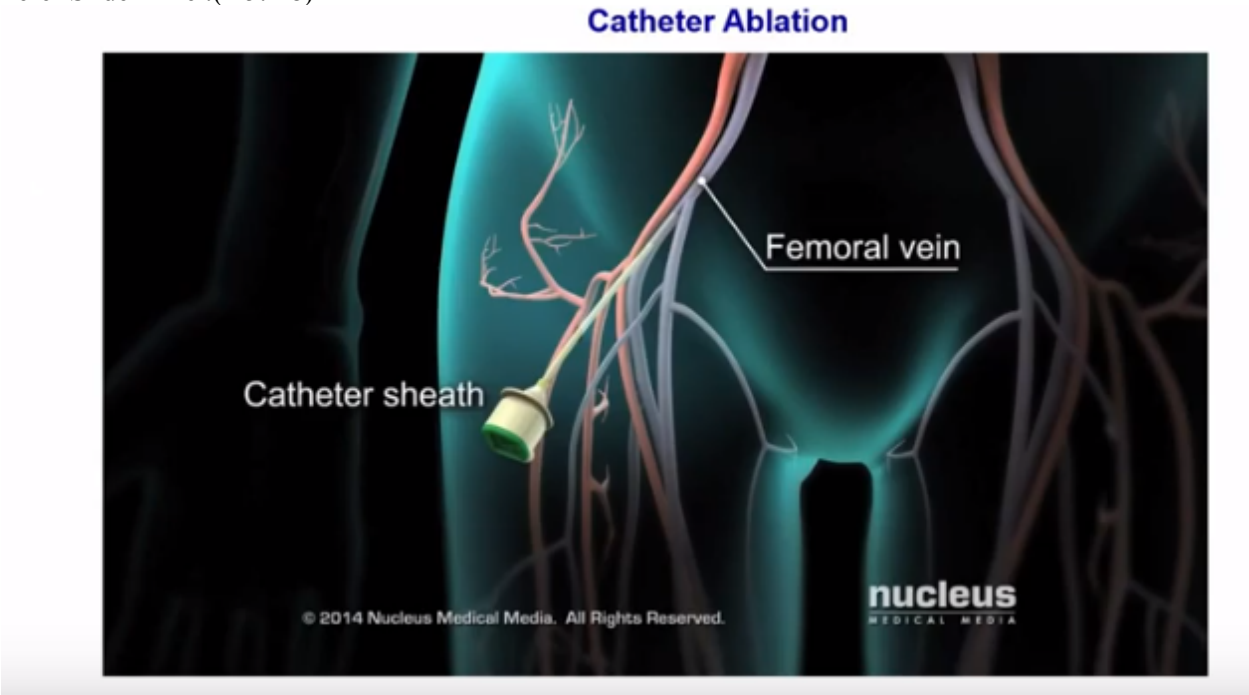

for certain types of arrhythmias a catheter ablation procedure may be necessary to stop the heart tissue from causing the arrhythmia, after numbing a small area in the groin with a needle the doctor will insert a short hollow tube called a catheters heath, into the femoral vein.

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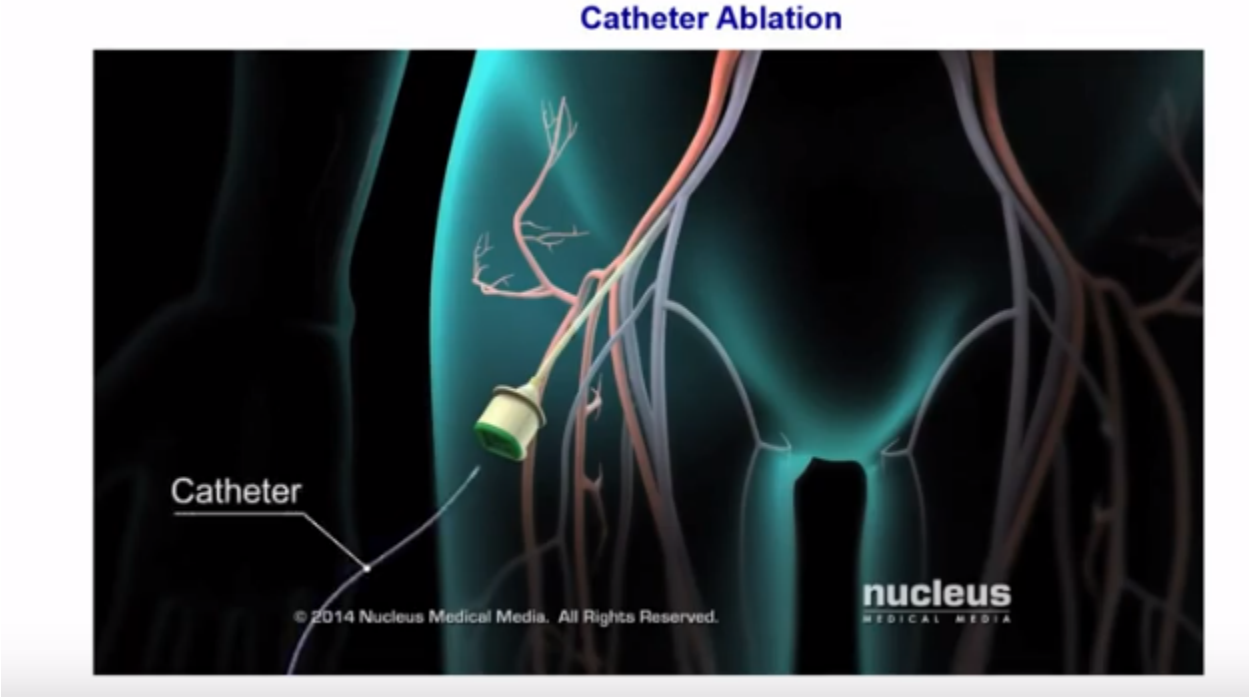

Next a long flexible tube called a catheter will be inserted through the sheath.

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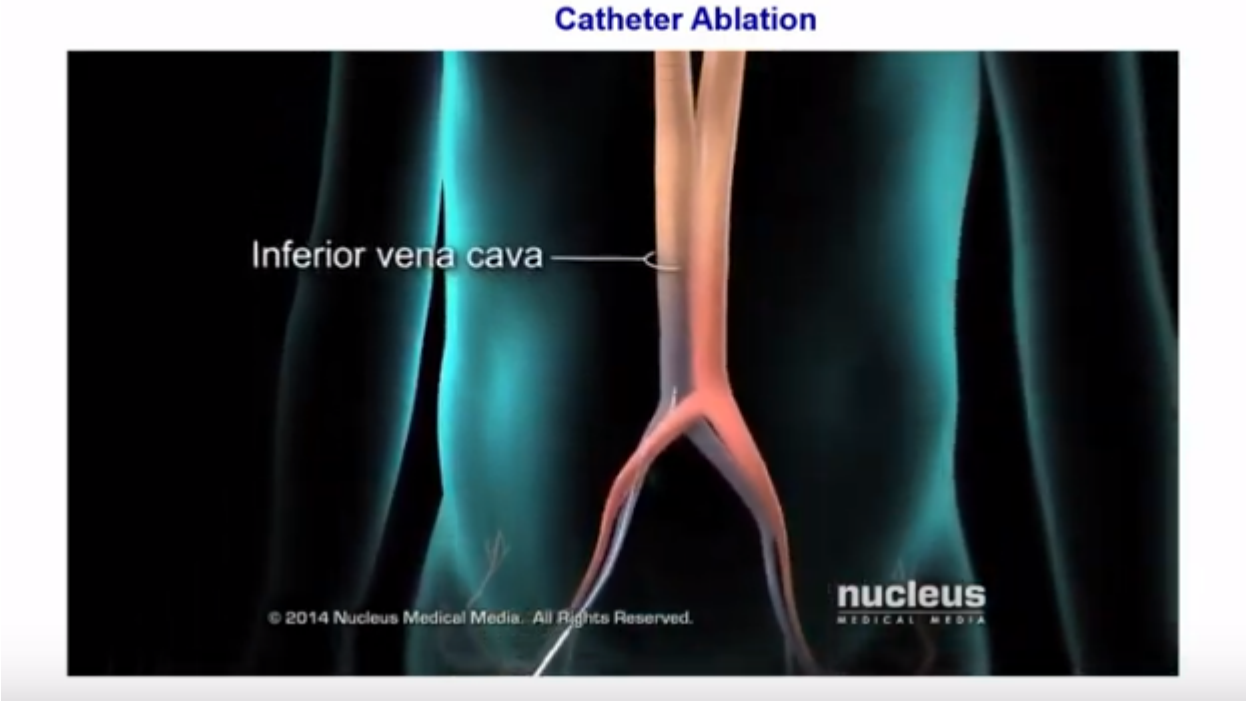

The doctor, will guide the catheter to the heart through a blood vessel that goes to the heart called the inferior vena cava. The location and progress of the catheter will be monitored.

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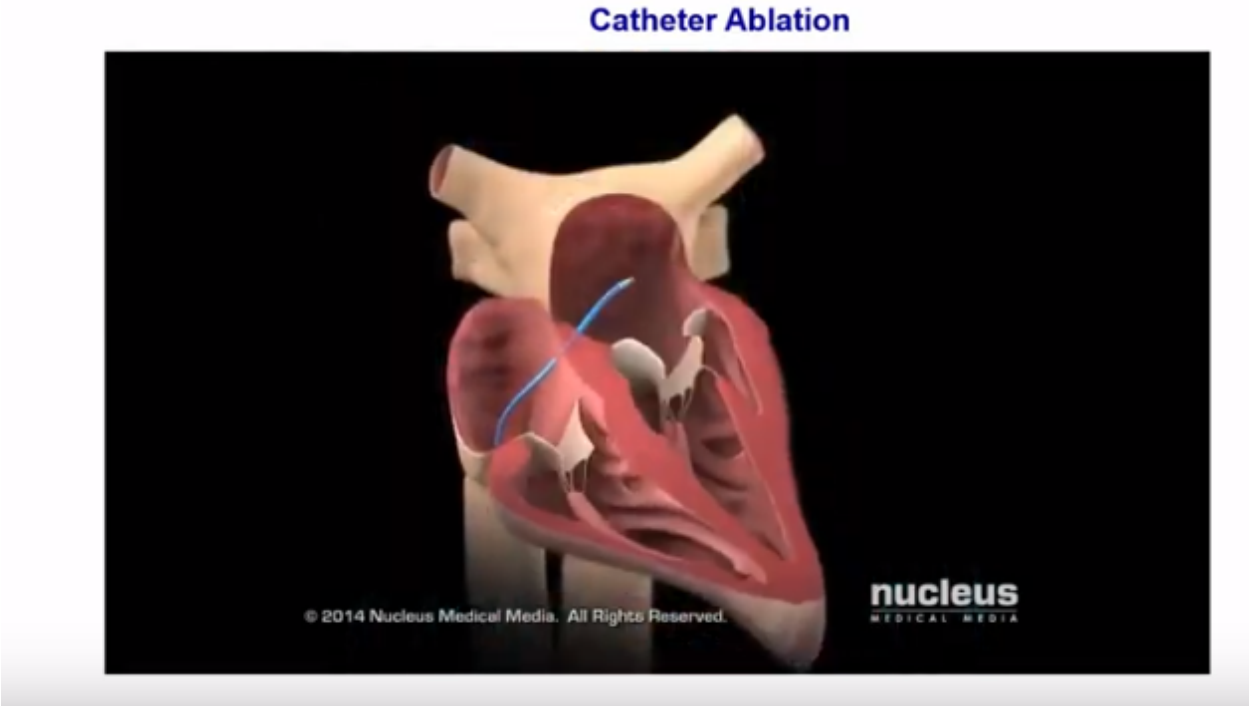

When the catheter reaches the heart the doctor will guide it to the area that is causing the arrhythmia,

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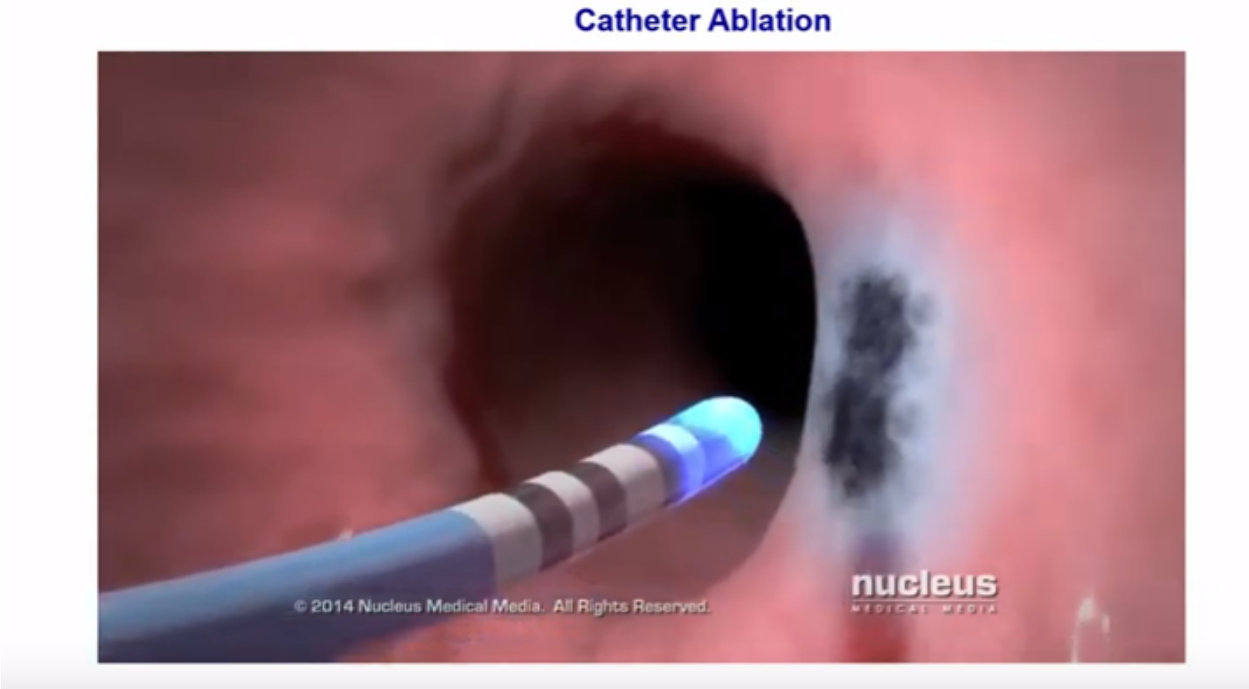

The doctor will find the problem areas using a 3D map of the electrical activity of the patient's heart. The tip of the catheter will emit either hot energy or cold energy, to ablate the tissue in this area. Ablation makes the treated area stop working.

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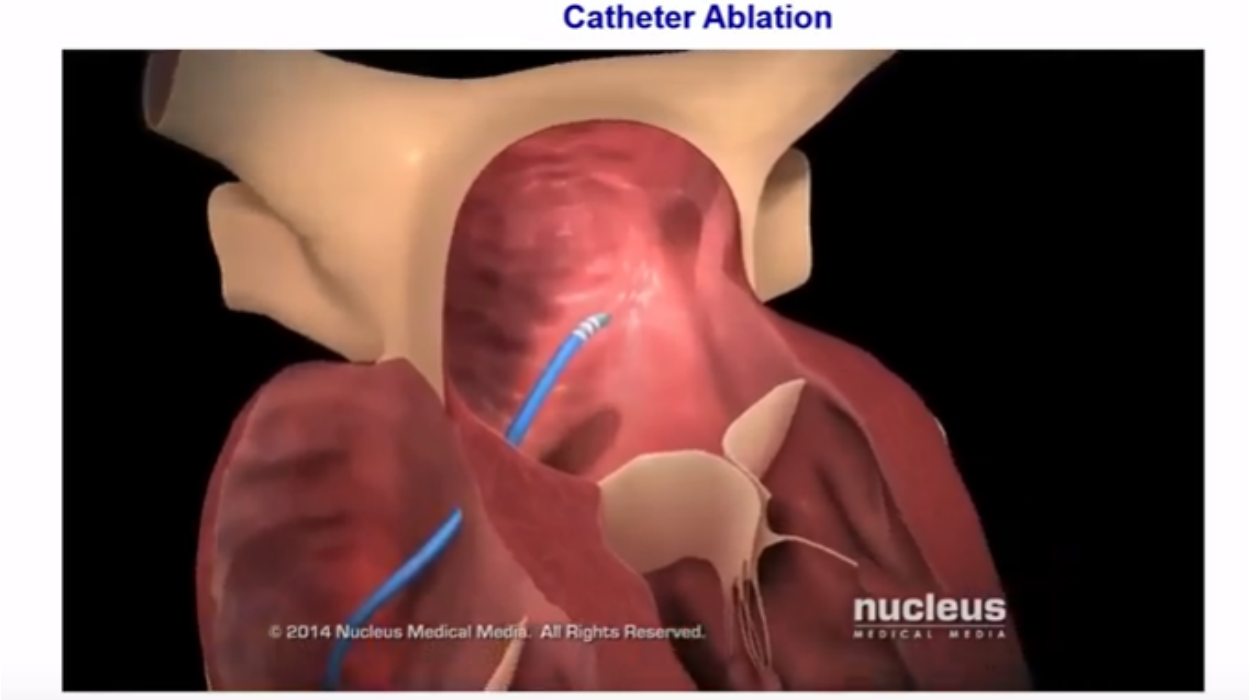

For and a trial arrhythmia, Doctor Will oblate the a trial tissue causing it,

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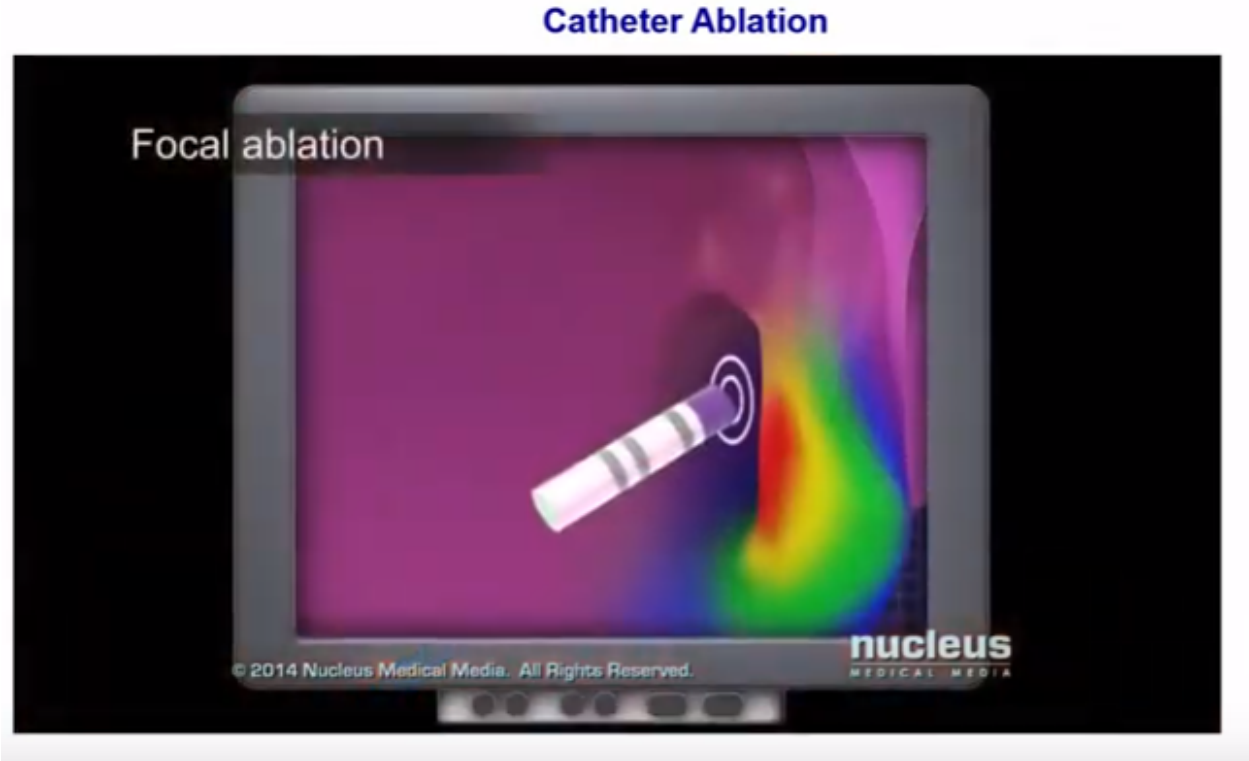

If the affected tissues are small well-defined areas the procedures called focal ablation or if the affected tissues are larger areas with more complex rhythm disturbances, the doctor may perform a procedure called ablation remodeling. Both types of ablation restore normal electrical impulses and prevent an arrhythmia from happening.

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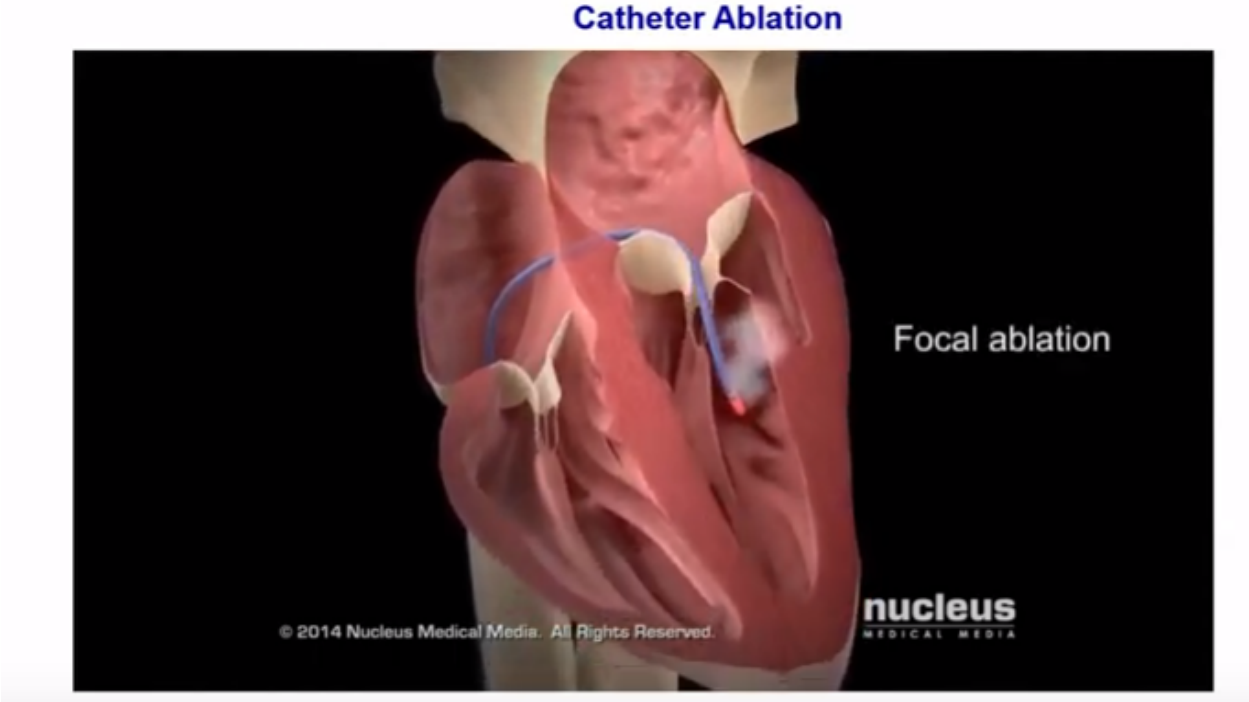

If the cause of the arrhythmias in the ventricle the doctor can do either focal ablation or

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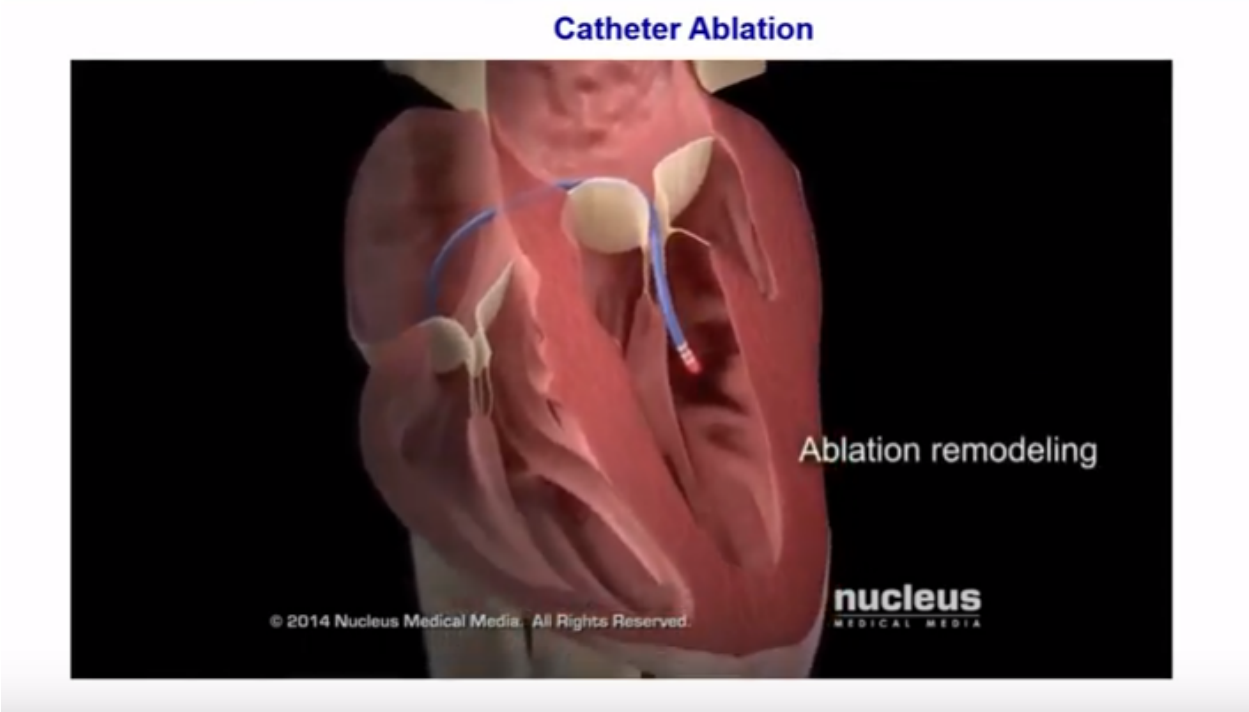

Ablation remodeling to treat more complex arrhythmias of the ventricle, Okay, so the video you have seen shows about the catheter ablation. Now let us see how can we design a sensor that can help us to understand the catheter contact force you understood right, that in the in the video that the carrier is inserted it is placed onto the heart right, to get the electrical signals once the electrical signals where is a misfiring is identified. You have to burn this with the help of RF ablation right, or container ablation.
Now when you are touching the heart tissue you should know how much force you are applying, this let's, let's say this is a catheter and I'm touching the heart tissue, how much force I'm applying to this heart it's very important, because more force will burn the other areas of the t of the heart, if less force will cause reoccurrence, so I had to use an optimized force right? So I had to design sensor that can help me to get the real-time contact force from the catheter. Now when I say help me am not actually helping me, is to help the surgeon. so when a surgeon is operating the, the patient and if he or she has to ablate the heart tissue, if the information on the force is provided through, the catheter contact then it makes surgery better, that is one of the aspect. second aspect is if you can have a haptic feedback to the catheter, because whenever you press right if you if you can take a pen and you can just press on your screen just don't press too much it'll break on, on, on the board you can to try to do that and what you when you press it what you feel, you feel force right did you feel a force how much force you are applying there is haptic feedback you, you have a feedback.

Now the catheter right now doesn't have this kind of feedback it can only show you the contact force what about, we add the haptic feedback to the catheter? Is it useful? that new cells we cannot only see the contact force. But we can also feel the force that you are applying, right? so that is the idea that is the motivation for, for me to teach you this particular module right and, and we will talk a little bit quickly

about how, we can fabricate a sensor that can be integrated onto this catheter and that can be used to you know in actual surgery and what of electronic module you can design. So as to understand this contact force measurement, right? So that is the idea.

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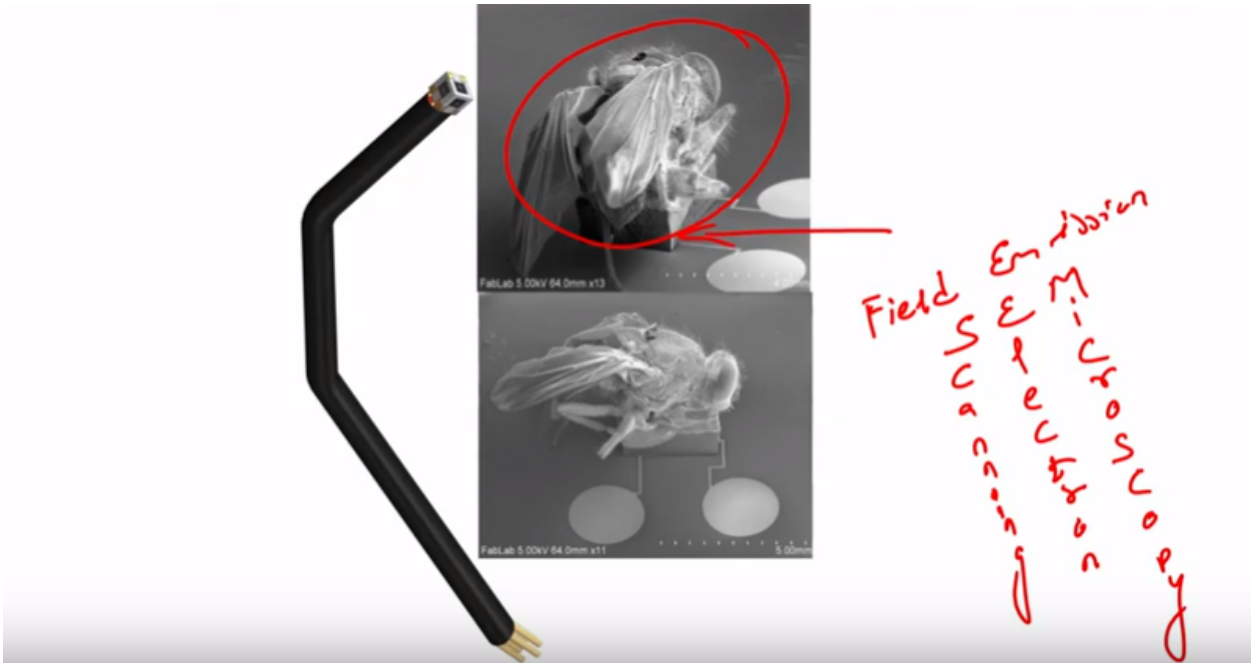

so if you see the slide what you see here is a housefly this is a house fly and house fly is sitting on the sensor this is the sensor that , we have designed now therefore this is a dead fly and this is the FESEM even, FESEM cells for field emission field emission field emission, Scanning Electron Microscopy , scanning electron microscopy or microscope all right , so field emission scanning, electron microscopy used to take this particular image , images of a housefly right ,housefly right sitting on the sensor sitting on the sensor. Now the idea was to understand, what is the weight of the housefly and can we measure the that weight with the help of the sensor, so that is the photograph for you, but let us not deviate our self too much from the actual problem actual problem is,

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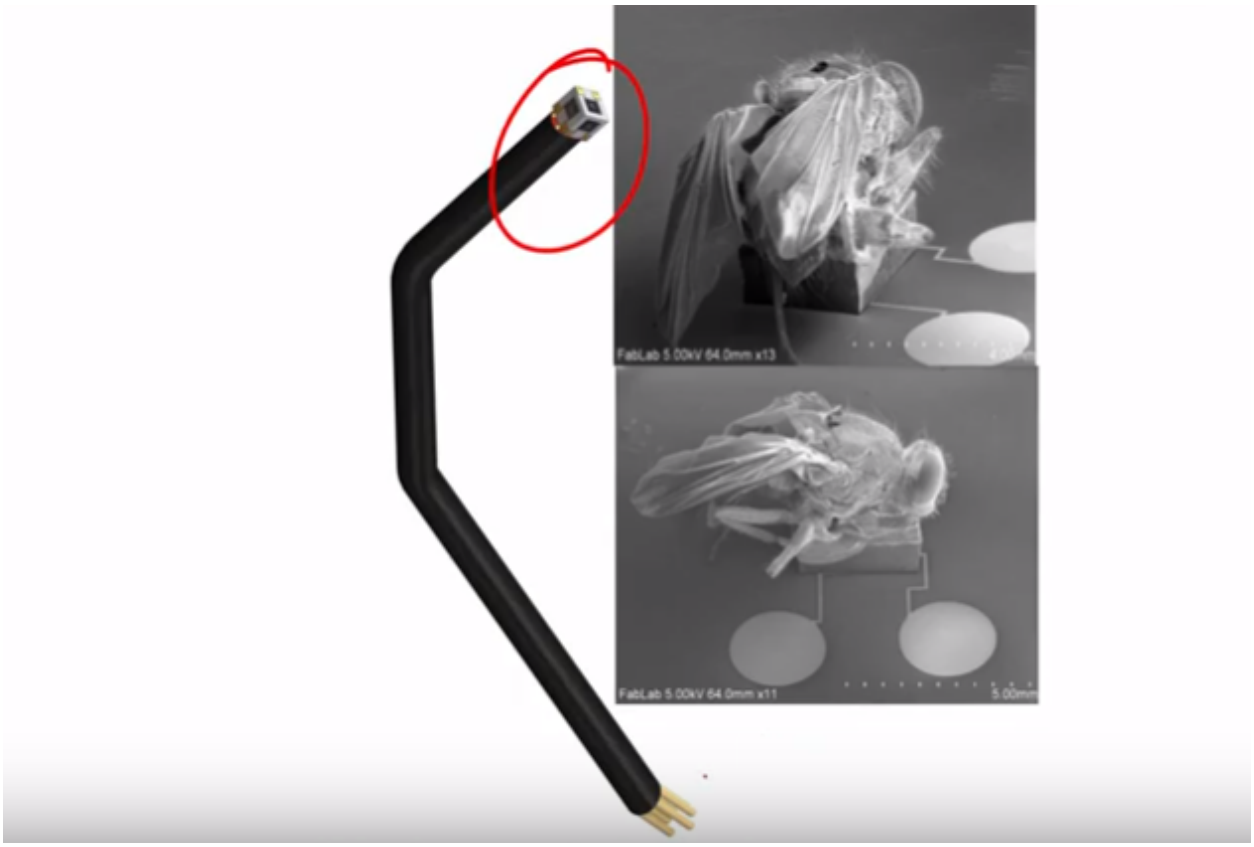

Whenever I am applying force on the heart, I want to see, what is a change? What is the amount of force that I am applying? That is a first task.

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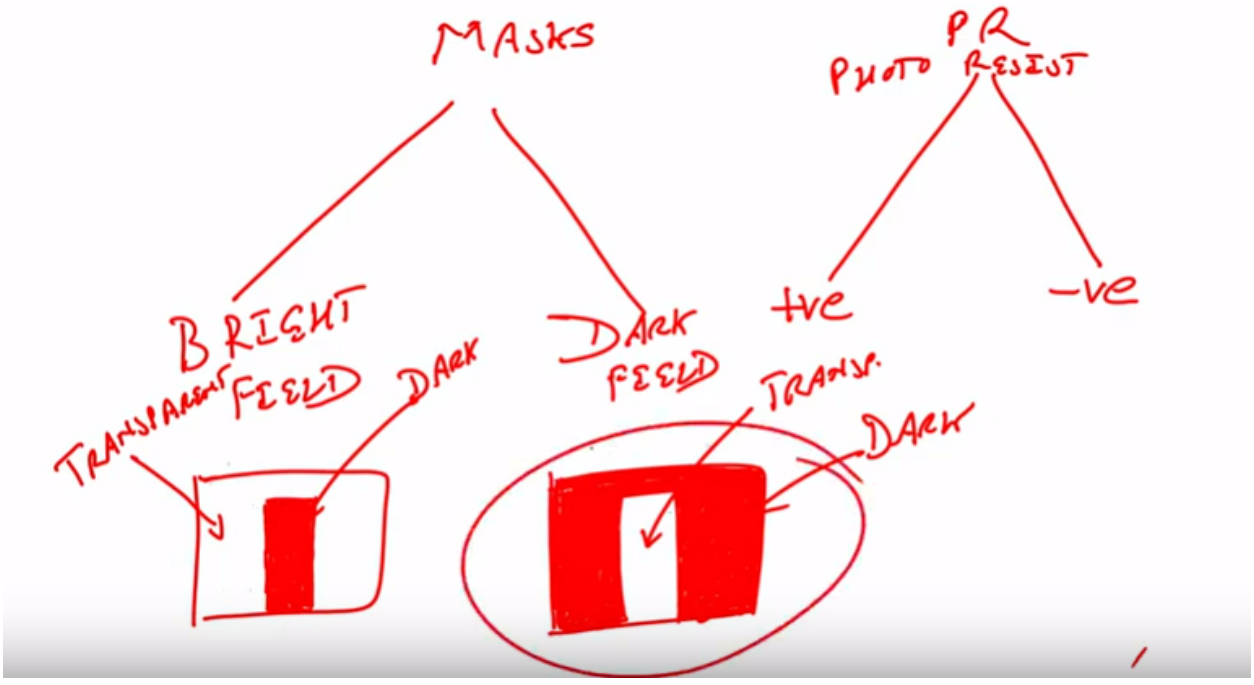

To understand that let us see, how can we have fabricate censor? To fabricate sensor, let us understand, first very quickly a few things right, the first thing is a photolithography. But before that let me explain you what are the masks, masks and I'll explain you photo resists, mask and photo resist, now when you talk about masks there are two types of masks bright field masks, bright field then dark field. I'll show you the bright field mask and our field mask in the next lecture right and when the core postures it's there are two types positive photo resist and negative photo resist right , this is photo resist for two resistance all right , bright field mask, dark field, positive photo resist, negative photo resist got it?

Now if I have bright field mask, that means let's say I'm drawing a circle or this particular pattern right and in this case I'm drying a dark field mask for you. so what do you understand I'd also show it to you like I said how the mask looks like just to quickly explain , you how the dark film mask schematic looks like okay? I'll just draw quickly this one, I'm sorry it takes a little bit more time, but it's very important for me to explain you this particular process, So that you're you can you can design a sensor and then integrate that sensor for the application that , we are talking about you can also use this sensor for other applications, okay? once you know the lithography process you can use it for a lot of other applications okay, so this is one mask that does make, let me help you with drawing another one which his here, okay, what do you see here and here is that, the here the field is bright, you see this field filled is transparent right and the pattern, the pattern is dark, field is transparent, pattern is dark, in this case field is dark, pattern is transparent. You understood that's why this is a bright field mask and this one is a dark field mask you got it? Bright, field and dark field, now let us understand one more thing is, if I use,

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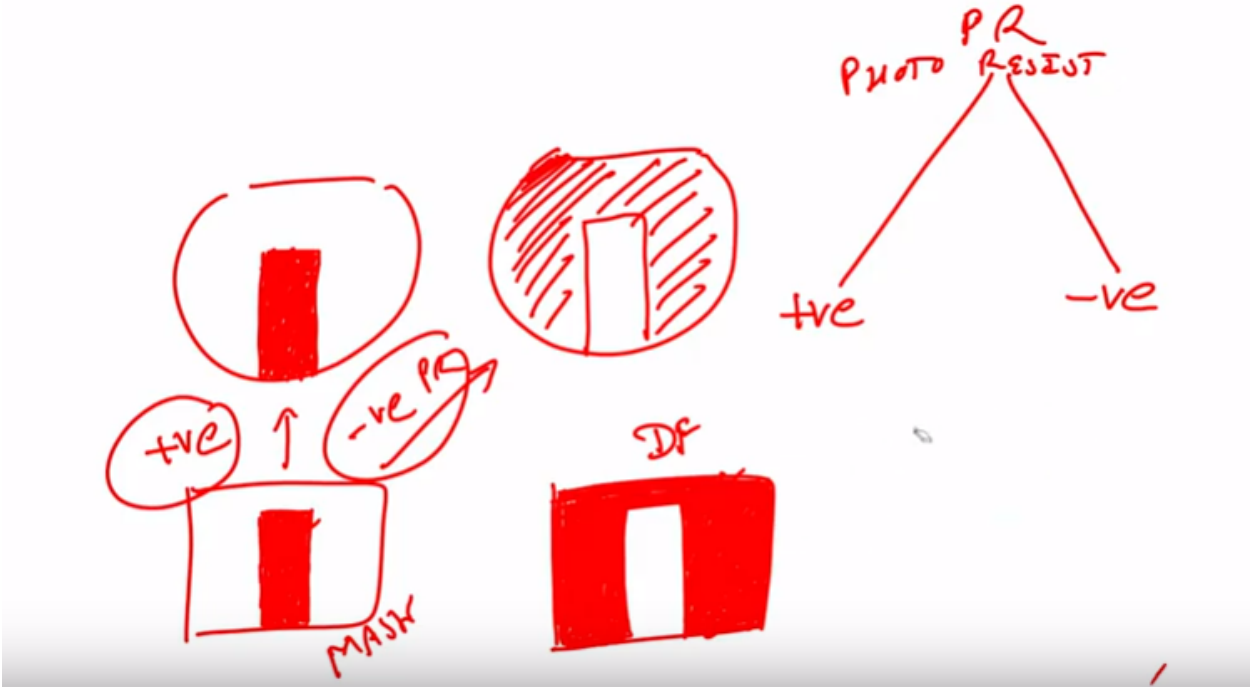

If I use a bright field mask okay, and I amusing a positive photo resist. So I am using bright field mask and I amusing a positive photo resist, then my silicon wafer my silicon wafer, will have a similar pattern, will have a similar pattern that is assumed that let me quickly draw like this that means that this same pattern can be transferred to the silicon substrate, right? If I use the rightful mask and positive photo resist if I'm using the right, film mask and positive photo resist right? but if I go for negative photo resist, my silicon wafer, my silicon wafer, will have this area transparent I'm sorry this area transparent and other area let me just draw like lines.

So that we save our time you assume that this line is completely filled like this one okay so when we have a negative photo resist then we have a pattern which is opposite to the mask this is my mask right I am using bright field mask, with positive photo resist and this mask with negative photo resist, when I am using positive photo resist similar pattern is transferred to the oxidized silicon wafer or a substrate and when I am using a negative photo resist, the opposite pattern is transferred to the substrate. This much is easy, now let us use a dark field mask, dark field mask and use silicon substrate hmm.

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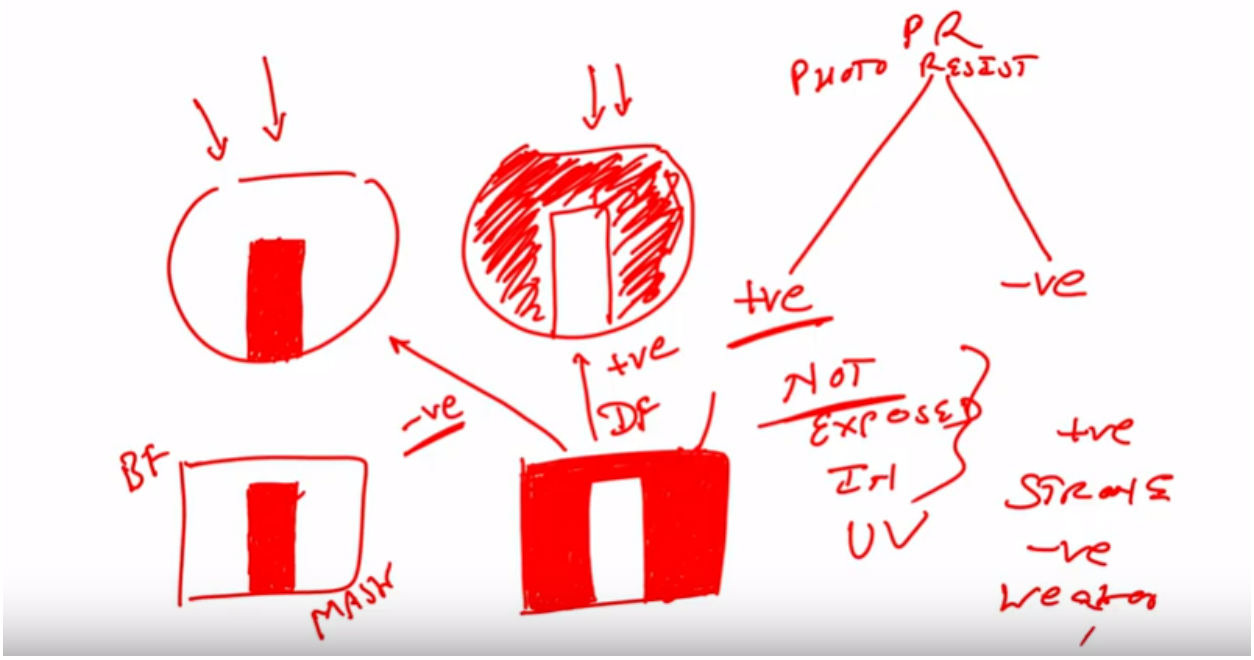

So let me just remove this one right, now with dark field mask, if I go for positive photo resist and if I use negative photo resist, what will happen? for positive photo resist, I will have my substrate looks like this and for negative photo resist I'll have a substrate which is which looks like this, one, now you see what is happening mmm the, the positive photo resist the area which is not exposed, the area which is not exposed in UV ultraviolet light, Will get stronger, in the case of positive photo resist, the area which is not exposed , will get stronger and that's why you are getting this wafer when because the area in this particular dark field mask, is not exposed, the red one is not exposed the transparent one , one is exposed. So that will become weaker, that's why what you find here is that all the area is stronger, except the area which is in the centre, because it is exposed, right? In case of negative photo resist the area, which is not exposed will get weaker the area which is not exposed.

Will get weaker and that's why what you see is this particular substrate you see here the area, which is not exposed is out and the area which is exposed this gen tine is intact, you got it. So dark field mask bright film mask right, bright field mask fill mask positive photo resist negative, photo resist positive photo resist, area that is not exposed, will get stronger positive, in negative photo resist area which is not exposed, will get weaker, easy? right extremely easy right, so let us let us see now how the electron, how the mask looks like and how the wafer looks like before we go to the to the actual in a fabrication.

So let me let me show it to you this the, the the how the mask looks like and how the wafer looks like in the next module followed by , which we will see how can we quickly perform a lithography process, to fabricate sensor, for the catheter ablation, right? And then we will see how can we design the electronic and distinct system right, then you, you just focus on the Atrial fibrillation part you understand what is a ablation? Catheter ablation, Then you , you understand what exactly lithography consists of in which we have discussed by masks and we are discussed the photo resist till then you take care I'll see you the next module where we discuss more about the mask and the wafer and then the sensor design . Bye