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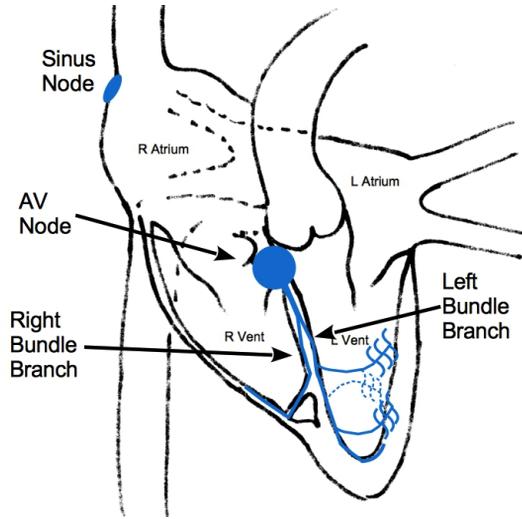
James Wilson, MD FACC

General and Interventional Cardiology

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What is normal rhythm?

The heart is separated into two upper chambers (atria) that receive blood and two lower chambers (ventricles)



that forcefully eject blood into arteries. The movement of upper and lower must be coordinated to achieve maximum efficiency. Fortunately, we are hardwired for just such efficiency.

The heart is its own master. Without external influence, it will repeat the motions of a beat unceasingly, unless it is deprived of energy. The process begins at the topmost point of the heart called the sinus node. The node is a focus of special heart cells whose purpose is to awaken with an electrical charge that passes from cell to cell. The message spreads to the center of the

heart, between the two upper and two lower chambers, where it finds another focus of special heart cells called the “junction” or **Atrio-Ventricular (AV) node**. The junction spreads out into the ventricles as a specialized network of cable-like cells that awaken and coordinate the action of these muscular pumping chambers.

The sinus node taps out time and the atria awaken to gently coax blood to the ventricles. The junction pauses to collect the message and directs the ventricles to follow that lead. Thus, the movement is atrium, pause then ventricle. Although the sinus node directs, it is influenced by hormones in the blood and messages from the brain to match the work of the heart to the needs of the body. It works faster or slower to match conditions. This is normal sinus rhythm.

What is Atrial Fibrillation?

The sinus node sends out its message to drift onto the AV node like a wave laps to a shoreline. In atrial fibrillation, no single point in the atrium is responsible for awakening. The atria are chaotic and roiling with electrical waves like bubbles of boiling water.

Facing such noise from above, the junction is overwhelmed. Only some of the messages are allowed to pass through. The result is an irregular heartbeat that is usually quite fast and whose timing no longer changes in response to the body's needs.

What does it feel like?

Very rarely, the rhythm may come and go unnoticed. Most often, it is felt as a fluttering or racing, which is disquieting, if not uncomfortable. Some people describe the sensation as an internal quickening or “glimmer”. At onset, anxiety and fatigue are also common. Shortness of breath or chest discomfort may be present, particularly when the heart rate is very fast.

In most of us, the atria are designed for a heart rhythm that originates in the sinus node. Atrial fibrillation has difficulty sustaining itself. Therefore, it will come and go in short episodes, called paroxysms. With time, the atria change and AFib gains an advantage. The paroxysms grow more frequent and prolonged. Eventually one episode will persist long enough that help is sought.

Who gets this?

AFib may have a specific precipitant like heart surgery or a severe excess of thyroid hormone. If so, resolution of the primary problem usually takes care of the rhythm. More commonly, it is the end result of several disorders: overfilled and overstretched atria due to heart valve disease, high blood pressure, obstructive sleep apnea, injury to the heart from heart attack, or toxins like alcohol.

Age and high blood pressure are the common causes of AFib.

The most important risk factor for AFib is age. With each decade after 40, the chance of AFib rises rapidly. Over the age of 75, almost one in ten people experience AFib intermittently or have the rhythm permanently. When AFib appears due to age and these risk factors, it is the heart's declaration that the rhythm can, and most likely will, occur repeatedly. Efforts to address underlying risks, like obesity, sleep apnea and high blood pressure help to prevent or delay recurrences.

Where does it come from?

Three major factors promote atrial fibrillation: Rogue heart cells, islands of scar tissue within heart muscle and poor communication between heart cells. Rogue cells are those that no longer listen to the sinus node and begin their own awakening in an effort to drive the heartbeat themselves. There may be many rogues vying for dominance at one time.

Scar tissue breaks up the

spread of an electrical message through the atria. Similarly, when heart cells cannot communicate with each other, messages become fragmented. The results of both are the swirling electrical signals that are AFib.

The important point is that these three factors can be controlled but not cured. Outside of the rare instance with a clear proximate cause of abnormal rhythm, the battle with atrial fibrillation will be long term and include lifestyle changes and medical therapy.

- A rogue cell
- Scar Tissue
- Poor Communication

What is the danger?

AFib is usually nonfatal. Symptoms of uncomfortable awareness of the heartbeat and exertional fatigue usually demand treatment. However, there are also potential consequences of the abnormal rhythm that require recognition and prevention.

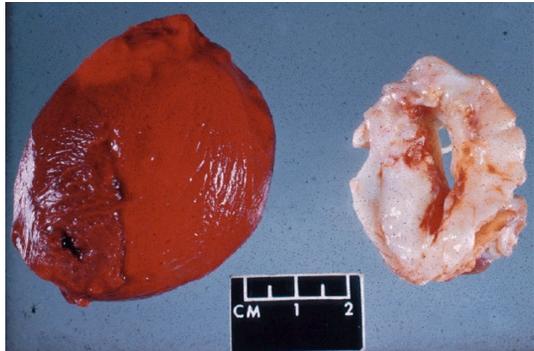
A heart racing unchecked for weeks on end will fatigue and eventually fail.

Muscular weakness of the ventricles becomes

progressively more disabling and may be fatal.

The most important complication of AFib is stroke. Blood clots may form in the heart and escape. A blood clot coming to rest in the brain causes the brain injury known as a stroke. Stroke due to AFib is usually either crippling or fatal.

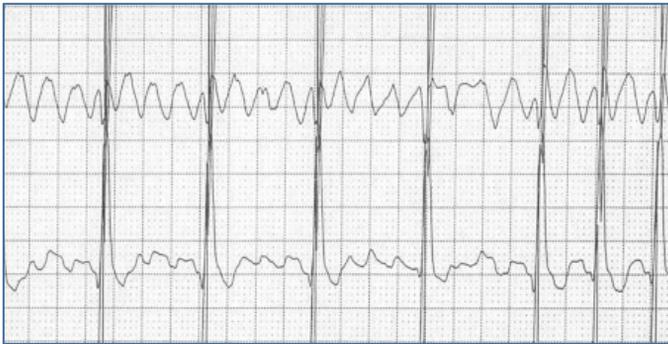
Both complications of AFib, heart failure and stroke, are preventable with proper treatment.



A blood clot that formed in someone with AFib as well as the heart valve that caused the rhythm.

Diagnosis

Before the EKG, people with symptoms of AFib were thought to have a nervous disorder detectable in the pulse. Even after the heart's irregularity was discovered to be the source of symptoms, it was still blamed on the brain and called *Delirium cordis*, the delirious heart.



AFib can be seen on an EKG. The electrical chaos in the atria is seen as coarse irregularity in the baseline with random intervals between the spikes of the ventricular beats.

A standard EKG lasts only ten seconds. Therefore, when AFib is intermittent, proof of its presence is most reliably sought using a portable device that records cardiac rhythm for as much as one month at a time. Implantable recording devices are also available.

Treatment

The goals of treatment are to **prevent heart failure** due to rapid heart rate, **prevent stroke** due to blood clotting and **relieve symptoms**. Symptoms may be due to the heart's rate, its irregularity or to reduced efficiency

Stroke is the most important complication of AFib and can be prevented using medicines that slow blood clotting called anticoagulants. The medicines include,

warfarin, apixaban, dabigatran, rivaroxaban and edoxaban. All are effective. Warfarin use requires regular blood testing.

Fortunately, even in AFib, stroke is uncommon in young people with normal hearts. The factors increasing the chance of stroke are listed above. These are used to determine the need for preventive treatment. Once initiated, anticoagulants are usually continued indefinitely.

CHF (heart failure)
Hypertension
Age (<65-1, >75-2)
Diabetes
Stroke
Vascular disease
Sex

Controlling Heart Rate in AFib

Prevent heart failure and reduce symptoms

Left alone, the sinus node will drive the heart at a rate of 100 beats/minute (BPM). In AFib, the junction is inundated with messages that swirl by 3-400 times/minute. It may allow enough of them through that a heart rate as high as 150-200 BPM is observed. When this rate is sustained for weeks at a time, the heart's physical performance declines, resulting in progressive heart failure.

*The goal is
<100 BPM*

A heart rate kept <100 BPM prevents heart failure and relieves the uncomfortable symptoms in many people affected by AFib. Commonly used medicines (below) slow the junction to help control heart rate.

Beta-blocker: Propranolol, Metoprolol

Calcium channel blocker: Verapamil, Diltiazem

Digoxin: used in specific circumstances

Even after the heart rate is under control, the disorganized rhythm may still affect the heart's efficiency and sap stamina. If so, relieving symptoms requires a return to normal rhythm.

Restoring Sinus Rhythm: Cardioversion

Cardioversion is the brief creation of an environment where the sinus node may resume leadership of the heart's rhythm. It can be done with a high dose of a type of medicine called an **Anti-Arrhythmic Drug (AAD)** or using Direct Current (DC) electrical shock.

*Electrical Shock
High dose AAD*

AADs are used most commonly to resolve AFib that is a few hours or days old. DC Cardioversion requires anesthesia and is used for more long-standing AFib or that which is resistant to AAD. A normal rhythm is restored 90-95% of the time, but AFib will return in 50% of people within one year.

*AFib returns in
50% at one year.*

Maintaining Sinus Rhythm: AAD

The roiling activity in the atria affected by AFib does not extinguish but instead maintains itself. Either rogue cells bent on creating chaos continue to fire unsilenced or the communication is so fractured that electrical signals dart through the

atria chasing each other around. AAD's affect heart cell communication. Under their influence, rogue cells are ignored and fractured signals extinguish themselves.

Each AAD has particular strengths and weaknesses. All require regular monitoring for potentially dangerous side effects. A few of the commonly used medicines are listed below.

Flecainide is very effective for AFib that occurs in the absence of underlying heart disease. It can be used in high dose to convert to sinus rhythm or daily as a preventive.

Propafenone is an alternative to flecainide with similar uses.

Sotalol is frequently used in people with underlying heart disease. It must be taken regularly.

Amiodarone is the most effective AAD, bar none. However, it must be taken regularly to be effective, causes difficulty with other medicines due to interactions and is troubled by many side effects.

Dronedarone is similar to amiodarone but less effective and with fewer side effects.

Surgical Procedures

Several surgical procedures will relieve symptoms or prevent the complications of AFib.

MAZE: Surgery can be used to intentionally place scar tissue in the atria.

Since scar does not transmit electrical messages, the scar placement is designed to

A MAZE prevents most, but not all AFib

prevent the swirling that can become AFib. The patterned scarring is often referred to as a “Maze”.

Catheters can be used to accomplish the same end in a non-surgical procedure called

RadioFrequency Ablation (RFA). The goal is symptom relief, succeeding in about $\frac{3}{4}$ people. It is not a cure or treatment to prevent stroke.

LAA occlusion: A small sac-like protrusion of the left atrium, known as the **Left Atrial**

Appendage (LAA), is where most blood clots will form in AFib. This “appendage” can be closed surgically or by using a small plug to fill the area.

LAA occlusion is used when the chance of suffering stroke due to AFib is high, but medicines to stop clotting cannot be used.

Conclusion

AFib is a non-fatal disturbance of the heart's rhythm with many different causes. It may be a side effect of some curable illness or a procedure performed, like heart surgery. In most of us, it is the result of increasing age, our heritage and other long-standing problems like high blood pressure and sleep apnea. Important points to remember include.

1. If you suspect that you are experiencing bouts of abnormal rhythm, request to wear a monitor to record the heart's activity during symptoms.
2. Medical treatment can control heart rate and/or heart rhythm to address the symptoms of AFib.
3. The most dangerous complication of AFib is stroke. The chance of stroke and need for preventive medical treatment should be discussed with your physician.
4. In the very rare circumstance that medicines fail to provide adequate control or protection, surgical procedures are available to control rhythm and prevent stroke.



James Wilson, MD FACC

Dr. Wilson is a Louisiana native and graduate of Tulane University Medical School in New Orleans, LA. He completed Cardiology training at Texas Heart Institute where he was later the Director of Education, Chief of Service and maintained the Robert Hall Laboratory for Heartsounds and physical examination. He also worked for several years as co-director of Cardiovascular MRI. He has published extensively on the heart and heart disease and is a contributing author to several textbooks on Heart Disease. He is presently in private practice, but maintains interest in teaching cardiovascular physical examination. His lectures are available on YouTube or at www.heartsounds.com.