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### Atrial Fibrillation Pathophysiology

Ellen MacDonald

ellen.macdonald@otterbein.edu

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# Atrial Fibrillation Pathophysiology

Ellen MacDonald RN, BSN, PCCN  
Otterbein University, Westerville, Ohio

## Introduction

Atrial Fibrillation is the most common cardiac dysrhythmia and has significant impact on morbidity and mortality (Lewis et al, 2014). It is estimated that by the year 2050 more than 12.1 million Americans will have atrial fibrillation (Miyasaka et al, 2006). The increasing prevalence of this condition necessitates the need for better understanding of the pathogenesis of atrial fibrillation to better direct treatment of AF. There are multiple risk factors for developing atrial fibrillation which emphasizes the multifactorial nature of this condition which in turn makes AF a difficult condition to manage. Atrial fibrillation is a serious heart condition on its own, but also drastically increases an individual's risk of stroke and new or worsening heart failure (McCance et al, 2019). Some of the most common risk factors for developing atrial fibrillation are as follows:

- Advanced age
- Obesity
- Hypertension
- Obstructive sleep apnea
- Heart failure
- Diabetes
- Ischemic heart disease
- Smoking

(Babapoor-Farrokhran et al, 2020; Centers for Disease Control and Prevention, 2020; Jung et al, 2018; Zhang et al, 2020)

## Signs & Symptoms

Atrial fibrillation is a challenging disease to treat and manage because in early stages it may be entirely asymptomatic and may occur and resolve spontaneously without the patient knowing that they were in atrial fibrillation at all, this is called paroxysmal atrial fibrillation (Sole et al, 2013). Atrial fibrillation can cause a rapid ventricular response leading to decreased cardiac output which is often when patients develop noticeable symptoms (McCance et al, 2019). The most common symptoms of atrial fibrillation include:

- Palpitations
- Exercise intolerance
- Fatigue
- Dizziness
- Lightheadedness
- Dyspnea
- Hypotension

(McCance et al, 2019) Because of the nonspecific nature of the symptomatology of atrial fibrillation as well as the high correlation with additional heart disease many patients do not recognize these symptoms as atrial fibrillation but as an exacerbation of heart failure symptoms (Denham et al, 2018). The relationship between AF and heart failure is cyclical, heart failure causes AF to worsen and AF puts additional stress on the heart muscle causing heart failure to worsen as depicted in Figure 1.

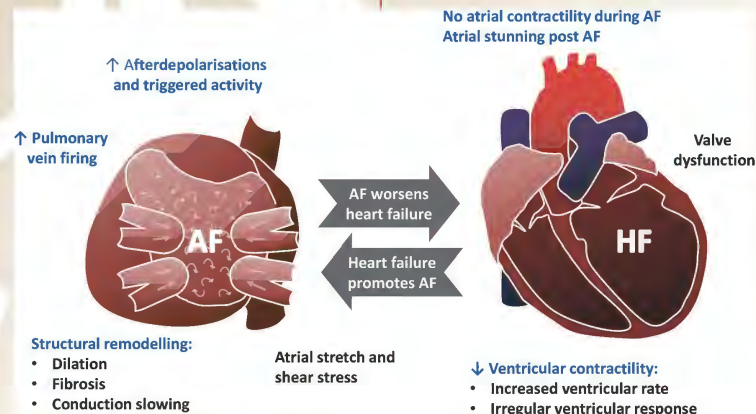


Figure 1. Illustrates the relationship between heart failure and AF (Denham et al, 2018)

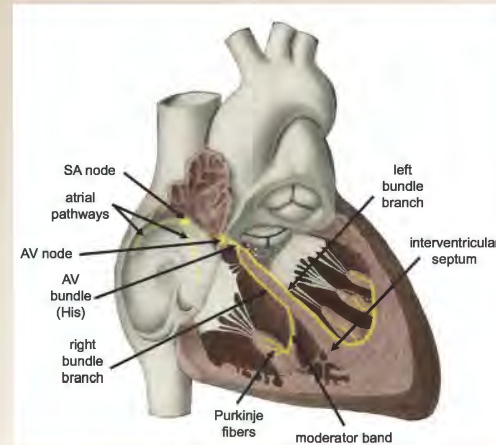


Fig 2. Depicts the cardiac conduction pathway

## Underlying Pathophysiology

Atrial fibrillation is an abnormal cardiac rhythm that occurs when electrical impulses originate from additional sources within the heart—known as ectopic foci—rather than from the sinoatrial (SA) node. The ectopic impulses cause the atria to quiver rather than contract and relax in the normal synchronous manner. This quivering motion allows blood to pool in the atria which significantly increases a patient's risk for developing a pulmonary embolism or stroke (Lewis et al, 2014). The additional electrical impulses are then conducted through the atria to the atrioventricular (AV) node where the impulse may be delayed, which results in an irregular rhythm, but one that is within normal rate of 60 to 100 ventricular beats per minute (McCance et al, 2019). In some instances the AV node fails to delay the ectopic conduction and this results in a rapid ventricular response with a sustained heart rate above 100 beats per minute. There is not one identifiable cause of those additional electrical impulses however, the presence of atrial remodeling leads to triggers that can cause those foci to send out electrical impulses and there are mechanisms such as hormonal and electrolyte disturbances that cause the heart to be vulnerable to those additional

impulses (McCance et al, 2019). When there is significant atrial remodeling, such as dilation or fibrosis from heart failure, the ectopic foci are more likely to develop but, may not be conducting persistently. When there is an imbalance or dysregulation of calcium ion channels within the heart muscle this can cause the heart muscle to become vulnerable to ectopic conduction (Denham et al, 2018). So when a patient has underlying heart failure this causes the atria to begin remodeling which can propagate ectopic foci and when combined with intermittent calcium ion disturbances this leads to a more prolonged vulnerability to those electrical impulses leading to persistent atrial fibrillation (DeGroot & Allesie, 2019). Other mechanisms that cause substrate vulnerability within the heart include hypoxia, as seen in patients with obstructive sleep apnea (Babapoor-Farrokhran et al, 2020) and endoplasmic reticulum stress caused by a high-fat diet often associated with patients who are obese (Zhang et al, 2020). The interrelation of structural remodeling causing the ectopic conduction triggers as well as leading to substrate vulnerability shows where the vicious circle between atrial fibrillation and heart failure begins.

## Significance of Pathophysiology

Understanding the relationship between structural heart damage increasing the risk of developing atrial fibrillation as well as atrial fibrillation then worsening the stress on the heart muscle allows health professionals to impart the seriousness of managing the interrelated health conditions that are often associated with AF. When patient has OSA but is non-compliant with wearing their CPAP at night and is experiencing more frequent hospitalizations from AF they need to be educated on how their health conditions are connected and that to more effectively manage their AF they should try to be more compliant with their CPAP at night in order to prevent additional damage to their heart. This is similar for patients with heart failure noticing that their heart failure worsens as their AF causes additional stress on their heart when they are in AF with RVR or their AF worsens when they become fluid overloaded from not adhering to a low-sodium diet.

## Importance of Nursing Care

- Providing education to patients regarding relationship between atrial fibrillation and other health conditions such as OSA or heart failure
- Encouraging heart healthy diet
- Encouraging weight loss for overweight or obese patients
- Encouraging smoking cessation
- Evaluating potential need for CPAP for OSA
- Monitoring for signs and symptoms of pulmonary embolism or stroke
- Educating patient and family members on signs of stroke

## Conclusion

While there is not one definable mechanism that causes atrial fibrillation to develop we are continuing to learn more about what causes AF and how to best treat it with the therapies currently available. Reducing modifiable risk factors and medically managing other health conditions that predispose patients to develop AF will help to reduce the morbidity and mortality of AF until more conclusive research is achieved to treat the underlying cause or causes of atrial fibrillation.

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