VOLUME - 14, ISSUE - 02, FEBRUARY - 2025 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Medicine

ATRIAL FIBRILLATION: A NARRATIVE REVIEW

Paola Andrea Vera Rincon MD. Universidad de Pamplona.

Oscar Fernando Ramírez Plata MD. Universidad de Pamplona.

ABSTRACT Atrial fibrillation (AF) is the most common cardiac arrhythmia, associated with increased morbidity and mortality. Its pathophysiology involves complex electrophysiological and structural changes, contributing to disease progression. Diagnosis relies on electrocardiography, continuous monitoring, and biomarkers. Management includes rate and rhythm control strategies, anticoagulation, and catheter ablation. Advances in artificial intelligence and wearable technology improve early detection and personalized treatment. Ongoing research aims to refine risk stratification and optimize therapeutic outcomes for AF patients.

KEYWORDS : Atrial Fibrillation; Electrophysiology; Anticoagulation Therapy; Catheter Ablation; Risk Stratification.

INTRODUCTION

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia encountered in clinical practice, characterized by irregular and often rapid atrial activity. It significantly increases the risk of stroke, heart failure, and overall mortality, making it a major public health concern. The global burden of AF is rising due to aging populations and the increasing prevalence of comorbidities such as hypertension, diabetes, and obesity. Epidemiological studies estimate that AF affects millions of individuals worldwide, with significant geographical and ethnic variations in prevalence and risk factors (1). Given its substantial morbidity and mortality, an improved understanding of AF is essential for optimizing its management.

This review aims to provide a comprehensive overview of AF, focusing on its epidemiology, risk factors, pathophysiology, diagnostic approaches, differential diagnoses, and treatment strategies. By integrating evidence from recent literature, this review seeks to enhance clinical decision-making and patient Outcomes (2).

Methods

A systematic literature review was conducted using four major databases: PubMed, Scopus, Web of Science, and Embase. The search was restricted to articles published between 2015 and 2025 to ensure the inclusion of recent advancements. The keywords used included "atrial fibrillation," "epidemiology," "risk factors," "diagnosis," and "treatment."

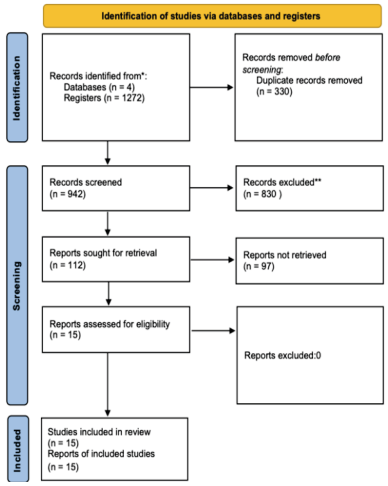

Figure 1. PRISMA.

Based on methodological rigor and clinical applicability, 15 key studies were selected to support this review. The selected literature covers epidemiological trends, novel diagnostic techniques, and emerging therapeutic interventions to provide a well-rounded perspective on AF management.

Epidemiology and Risk Factors

Atrial fibrillation (AF) is a growing global health concern, with its prevalence and incidence increasing due to aging populations and rising cardiovascular risk factors. Estimates suggest that millions of individuals worldwide are affected, with a higher burden observed in developed countries. The incidence of AF is strongly associated with advancing age, making it a predominant condition in elderly populations (3).

Risk factors for AF can be categorized into modifiable and non-modifiable elements. Among the non-modifiable factors, age remains the most significant, followed by genetic predisposition and male sex. In contrast, modifiable factors such as hypertension, obesity, diabetes, and obstructive sleep apnea play a crucial role in disease progression. Effective management of these risk factors can substantially reduce AF onset and complications (4).

Pathophysiology of Atrial Fibrillation

The pathophysiology of atrial fibrillation (AF) is complex, involving multiple electrophysiological and structural mechanisms that contribute to its initiation and maintenance. Electrophysiologically, AF is driven by abnormal atrial automaticity, triggered activity, and reentrant circuits. Rapid ectopic discharges from the pulmonary veins often act as primary triggers, leading to chaotic electrical impulses and loss of coordinated atrial contraction (5).

Structural and electrical remodeling further perpetuate AF, making it more persistent over time. Electrical remodeling results in shortened atrial refractory periods and reduced conduction velocity, facilitating reentry. Structural remodeling is characterized by atrial fibrosis, dilation, and inflammation, which compromise normal conduction pathways and promote arrhythmogenic substrates (6). These changes create a vicious cycle, where prolonged AF episodes induce more remodeling, increasing the likelihood of recurrence and progression to a permanent state.

AF is closely linked to various cardiovascular diseases, including hypertension, heart failure, and coronary artery disease. The presence of these conditions exacerbates atrial remodeling and increases AF susceptibility. Understanding these mechanisms is essential for developing targeted therapeutic strategies aimed at preventing disease progression and improving patient outcomes.

Clinical Classification of Atrial Fibrillation

Atrial fibrillation (AF) is classified into different subtypes based on duration and underlying etiology, which have important implications for management and prognosis. The primary classifications include paroxysmal, persistent, long-standing persistent, and permanent AF. Paroxysmal AF is self-terminating within seven days, while persistent AF lasts beyond this period and often requires intervention for termination. Long-standing persistent AF persists for more than 12 months, and permanent AF is accepted by both the clinician and patient as irreversible (7).

Another key distinction in AF classification is valvular versus non-valvular AF. Valvular AF refers to cases associated with moderate-to-severe mitral stenosis or the presence of mechanical heart valves, necessitating specific anticoagulation strategies. Non-valvular AF, in contrast, is more common and encompasses cases without these structural abnormalities, often linked to hypertension, obesity, and metabolic syndromes (8).

Subclinical AF, detected through prolonged monitoring such as implantable loop recorders, presents a growing challenge in cardiovascular medicine. Many individuals remain asymptomatic but are at increased risk for thromboembolic events. Advances in wearable technology and continuous cardiac monitoring have improved detection rates, aiding in early intervention and stroke prevention.

Clinical Manifestations of Atrial Fibrillation

Atrial fibrillation (AF) presents with a wide spectrum of clinical manifestations, ranging from mild palpitations to severe cardiovascular complications. Typical symptoms include irregular heartbeats, dizziness, fatigue, dyspnea, and chest discomfort. However, some patients may experience atypical symptoms such as cognitive impairment, anxiety, or nonspecific malaise, complicating timely diagnosis (8).

A significant proportion of AF cases remain asymptomatic, often detected incidentally during routine examinations or cardiac monitoring. Despite the absence of symptoms, asymptomatic AF is associated with a higher risk of stroke and adverse cardiovascular outcomes. The lack of early diagnosis and intervention in these patients contributes to disease progression and increased morbidity (9).

Beyond direct cardiovascular risks, AF substantially impacts patients' quality of life. The unpredictable nature of symptoms, frequent hospitalizations, and need for long-term anticoagulation therapy contribute to psychological distress and reduced physical functioning. Studies have shown that AF patients often report lower scores in health-related quality of life assessments compared to the general population. Effective symptom management and rhythm control strategies are essential to improving overall well-being and preventing complications associated with AF (10).

Diagnosis of Atrial Fibrillation

The electrocardiogram (ECG) remains the gold standard for diagnosing atrial fibrillation (AF), characterized by the absence of distinct P waves and irregular RR intervals. A standard 12-lead ECG is essential for confirming AF episodes, especially in symptomatic patients. However, due to the paroxysmal nature of AF, a single ECG recording may not always detect intermittent arrhythmias, necessitating prolonged monitoring (9).

For patients with suspected AF but inconclusive initial ECG findings, ambulatory monitoring techniques such as Holter monitors, event recorders, and implantable loop recorders provide extended rhythm surveillance. Wearable devices, including smartwatches and patches with ECG capabilities, have emerged as promising tools for early AF detection, particularly in asymptomatic individuals (10).

Beyond electrophysiological assessments, biomarkers and imaging studies play an increasingly important role in AF evaluation. Elevated levels of natriuretic peptides, troponins, and inflammatory markers have been associated with AF burden and progression. Advanced imaging techniques, such as echocardiography and cardiac MRI, help assess atrial structure, fibrosis, and thrombus formation, contributing to risk stratification and therapeutic decision-making (11). A comprehensive diagnostic approach integrating ECG, monitoring devices, and biomarker analysis enhances early detection and management of AF.

Treatment Strategies

Rate Control vs. Rhythm Control

The management of atrial fibrillation (AF) involves two primary strategies: rate control and rhythm control. Rate control focuses on maintaining an adequate ventricular rate using beta-blockers, calcium channel blockers, or digoxin without necessarily restoring sinus rhythm. Rhythm control, on the other hand, aims to restore and maintain sinus rhythm through antiarrhythmic drugs, cardioversion, or catheter ablation (10). The choice between these approaches depends on patient characteristics, symptom burden, and comorbidities.

Recent evidence suggests that rhythm control may provide superior long-term cardiovascular outcomes, particularly in patients with early AF and high cardiovascular risk. However, the recurrence rate remains high, necessitating individualized decision-making. Rate control is often preferred in older patients with minimal symptoms, while rhythm control is considered in younger individuals, those with heart failure, or those experiencing significant symptomatology (11).

Cardioversion

Cardioversion can be performed electrically or pharmacologically. Electrical cardioversion involves delivering a synchronized shock to restore sinus rhythm, whereas pharmacological cardioversion uses antiarrhythmic drugs such as amiodarone or flecainide (12). Indications include symptomatic AF with hemodynamic instability or failure of rate control strategies.

However, cardioversion carries a risk of thromboembolism, necessitating adequate anticoagulation. Patients with AF duration exceeding 48 hours require at least three weeks of anticoagulation prior to cardioversion unless a trans-esophageal echocardiogram excludes left atrial thrombus. Post-cardioversion anticoagulation is recommended for at least four weeks to minimize stroke risk (13).

Antithrombotic Management

Anticoagulation is essential in AF management to prevent stroke and systemic embolism. Direct oral anticoagulants (DOACs), including rivaroxaban, apixaban, and dabigatran, have largely replaced vitamin K antagonists (VKAs) due to their superior safety profile and ease of use. The choice of anticoagulant is guided by the CHA DS -VASc score, which estimates thromboembolic risk, and the HAS-BLED score, which assesses bleeding risk (14). Patients with a CHA DS -VASc score of 2 or higher in men and 3 or higher in women are recommended for long-term anticoagulation.

Catheter Ablation

Catheter ablation is an effective strategy for rhythm control in patients with symptomatic AF refractory to medical therapy. The primary technique involves pulmonary vein isolation, targeting the ectopic triggers responsible for AF initiation. Other techniques include radiofrequency ablation and cryoablation, both of which have demonstrated efficacy in reducing AF burden (15).

Clinical trials have shown that catheter ablation improves quality of life and reduces AF recurrence compared to antiarrhythmic drugs. However, success rates vary, and repeat procedures may be required. Long-term outcomes indicate that early intervention with ablation may offer superior benefits in select populations.

Devices and Surgery

For patients with contraindications to long-term anticoagulation, left atrial appendage closure devices, such as the Watchman device, provide an alternative for stroke prevention. These devices mechanically occlude the left atrial appendage, the primary site of thrombus formation in AF (15).

Surgical ablation is considered in patients undergoing concomitant cardiac surgery or those with highly symptomatic, refractory AF. The Cox-Maze procedure, which creates strategic atrial lesions to disrupt AF pathways, remains an effective option in select patients.

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