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ATRIAL FIBRILLATION AND STROKE RISK: PREVENTION STRATEGIES AND PUBLIC HEALTH IMPLICATIONS

Natalia Matylda Ziemba-Furgała *(Corresponding Author, Email: nataliaziembafurgala@gmail.com)*
Ministry of the Interior and Administration Hospital in Rzeszow, Krakowska 16, 35-111 Rzeszow, Poland
ORCID ID: 0009-0009-5031-3930

Agnieszka Szwed
MSWiA Hospital, Krakowska 16, 35-111 Rzeszow, Poland
ORCID ID: 0009-0003-6395-5365

Katarzyna Anna Borzęcka
Medical Center in Łańcut Sp. z o.o., Ignacego Paderewskiego 5, 37-100 Łańcut, Poland
ORCID ID: 0009-0007-4084-4370

Ewa Maria Polewczak-Karp
Medical Center in Łańcut Sp. z o.o., Ignacego Paderewskiego 5, 37-100 Łańcut, Poland
ORCID ID: 0009-0006-6411-4826

Daria Aleksandra Warzocha-Żurek
Clinical Provincial Hospital in Rzeszow, Lwowska 60, 35-301 Rzeszow, Poland
ORCID ID: 0009-0005-5756-2404

Krystian Andryszko
Clinical Regional Hospital of Saint Jadwiga The Queen in Rzeszów, Lwowska 60, 35-301 Rzeszów, Poland
ORCID ID: 0009-0006-6170-5663

Aleksandra Sołtys
University of Rzeszow, Poland
ORCID ID: 0009-0007-2557-2696

Marcelina Dymon
University of Rzeszow, Poland
ORCID ID: 0009-0000-8008-7932

Paulina Krysa
City Hospital of John Paul II in Rzeszów, Rycerska 4, 35-241 Rzeszów, Poland
ORCID ID: 0009-0000-6633-3586

Katarzyna Wawrzonek
Clinical Provincial Hospital of Saint Jadwiga the Queen in Rzeszow, Poland
ORCID ID: 0009-0007-6883-422X

ABSTRACT

Atrial fibrillation is the most common sustained cardiac arrhythmia and a major risk factor for stroke. The aim of this review is to present the relationship between AF and stroke risk through an analysis of current epidemiological data, pathophysiological mechanisms, risk factors, and prevention strategies.

This review is based on an analysis of recent literature and clinical guidelines. Patients with atrial fibrillation have a significantly increased risk of stroke, which is often associated with greater severity and poorer outcomes. Risk stratification tools such as CHA_2DS_2-VASc and HAS-BLED play a key role in guiding individualized therapy. Anticoagulation remains the cornerstone of stroke prevention, supported by management of risk factors and lifestyle modification. Early detection, particularly in asymptomatic patients, is also crucial.

Despite the availability of effective preventive strategies, their implementation in clinical practice remains suboptimal. Effective stroke prevention requires an integrated approach combining risk assessment, appropriate treatment, and early diagnosis.

KEYWORDS

Atrial Fibrillation, Stroke, Prevention, Public Health, Anticoagulation, CHA_2DS_2-VASc, HAS-BLED

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1. Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia and represents a significant challenge for modern medicine and public health [8]. It is characterized by disorganized electrical activity of the atria, leading to ineffective atrial contraction, irregular ventricular response, and an increased risk of thromboembolic complications, particularly stroke.

The prevalence of AF has been steadily increasing worldwide, largely due to population ageing and the growing burden of chronic diseases such as hypertension, diabetes, and obesity [4, 25]. This trend is expected to continue, placing increasing pressure on healthcare systems.

Atrial fibrillation is strongly associated with an elevated risk of ischemic stroke, which is approximately fivefold higher compared to individuals without this arrhythmia [5]. AF related strokes are typically more severe and prone to occur with higher mortality and long-term disability [15, 12]. It is estimated that AF accounts for approximately 15–25% of all ischemic strokes [8].

From a public health perspective, atrial fibrillation contributes substantially to burden healthcare systems, cause long-term care needs, and reduce quality of life [2, 23].

Effective stroke prevention in patients with AF requires a comprehensive approach, including anticoagulation, management of comorbidities, and lifestyle modification [10, 7]. Early identification of high-risk individuals is essential to reduce thromboembolic events. Especially that, atrial fibrillation may remain asymptomatic and undiagnosed for long periods, with stroke often being the first clinical manifestation. This highlights the importance of early detection and screening strategies [22, 5].

The aim of this review is to provide an extensive overview of the relationship between atrial fibrillation and stroke risk, with particular emphasis on epidemiology, pathophysiology, risk factors, and prevention strategies.

2. Methodology

This study is a complex overview of an analysis of current scientific literature concerning AF and the risk of stroke. The literature search was conducted using recognized databases, including PubMed and Google Scholar. The search strategy included keywords such as "atrial fibrillation," "stroke," "stroke risk," "prevention," "anticoagulation," "public health" and was primarily limited to English-language publications from recent years, with particular emphasis on review articles, clinical studies, and current clinical guidelines. The cited biography at its core addresses the epidemiology of atrial fibrillation, pathophysiological mechanisms leading to stroke, risk factors, and prevention strategies for thromboembolic complications.

Publications with limited scientific value, studies not directly related to the topic, and descriptive articles lacking relevant clinical data were excluded. The collected data were analyzed qualitatively, and their synthesis enabled a comprehensive overview of the relationship between atrial fibrillation and stroke risk, as well as available prevention strategies.

3. Results

3.1 Epidemiology

It is estimated that over 30 million individuals are affected globally by the atrial fibrillation, and its prevalence continues to rise [4], placing it as the most common sustained cardiac arrhythmia worldwide. In developed countries, atrial fibrillation affects approximately 1–2% of the general population, increasing to up to 10% among individuals over 65 years of age which is resulting with a significant epidemiological problem in ageing societies [25]. Elderly individuals are particularly vulnerable due to the presence of multiple comorbidities, including hypertension, heart failure, and diabetes. Epidemiological projections suggest that the number of patients may double in the coming decades, posing a major challenge for healthcare systems [11].

Atrial fibrillation is a major risk factor for stroke and unfortunately in addition stroke is often the first manifestation of previously unrecognized disease [22, 5]. It is estimated to account for approximately 20–30% of all ischemic strokes [8] and patients with it have an approximately fivefold increased risk of stroke compared to those without this arrhythmia [5]. Moreover, strokes related to it are typically more severe and associated with higher mortality and greater risk of long-term disability highly reducing quality of life [15, 12]. All of above highlight the importance of early detection and screening strategies for patients affected by atrial fibrillation.

From a public health perspective, atrial fibrillation and stroke impose a substantial burden on healthcare systems as they are associated with high treatment costs, frequent hospitalizations, and the need for long-term care [23, 2]. Stroke remains one of the leading causes of disability worldwide, resulting in significant social and economic consequences [2].

Regional differences in AF prevalence are also worth to be studied. Higher prevalence rates are observed in developed countries, partly due to longer life expectancy and better diagnostic capabilities. In contrast, disease may be underdiagnosed in developing regions due to limited access to healthcare and diagnostic tools [25].

In summary, both atrial fibrillation and stroke represent a growing global public health challenge. Their increasing prevalence and serious clinical consequences underline the need for effective prevention strategies and improved early detection.

3.2 Pathophysiology: Atrial Fibrillation Leading To Stroke

AF leads to significant hemodynamic disturbances and alterations in intracardiac blood flow, which promote thrombus formation and increase the risk of stroke. The key mechanism underlying thromboembolic complications is blood stasis within the atria, particularly in the left atrium and the left atrial appendage [8].

Under normal conditions, the atria contract in a coordinated manner, enabling efficient blood flow into the ventricles. In atrial fibrillation, chaotic electrical activity results in ineffective atrial contractions and reduced blood flow velocity, leading to blood stasis and creating favorable conditions for thrombus formation. Additionally, is associated with endothelial dysfunction and activation of inflammatory and prothrombotic pathways. These processes contribute to a hypercoagulable state and facilitate thrombogenesis [7]. Formed thrombi may subsequently embolize to the cerebral circulation, leading to ischemic stroke. Virchow's triad, consisting of blood stasis, endothelial injury, and hypercoagulability, plays a central role in the pathogenesis of thromboembolic events and unfortunately all three components are present in patients with atrial fibrillation, further increasing stroke risk.

Stroke risk in atrial fibrillation is not uniform and depends on the presence of additional clinical risk factors such as age, hypertension, diabetes, and heart failure. These factors enhance thrombogenesis and

increase susceptibility to complications [14]. Related strokes are typically more severe compared to strokes of other etiologies. This is largely due to the formation of larger thrombi in the atria, which may occlude major cerebral arteries resulting in higher mortality and a greater risk of long-term disability [15, 12].

Understanding the pathophysiological mechanisms linking atrial fibrillation and stroke is essential for effective prevention, enabling identification of high-risk patients and implementation of appropriate preventive strategies, including anticoagulation therapy.

3.3 Clinical Presentation And Types Of Atrial Fibrillation

Atrial fibrillation presents in different clinical forms, which have important implications for disease progression and treatment strategies. Three main types are recognized: paroxysmal, persistent, and permanent [8].

- Paroxysmal AF is characterized by self-terminating episodes, typically resolving within 48 hours, although they may last up to 7 days.
- Persistent AF lasts longer than 7 days and usually requires medical intervention, such as cardioversion.
- Permanent AF is diagnosed when restoration of sinus rhythm is not possible or not pursued.

Clinical symptoms vary and may include palpitations, dyspnea, fatigue, dizziness, and reduced exercise tolerance. However, a significant proportion of patients remain asymptomatic and those patients are particularly concerning, as they may remain undiagnosed for long periods. In many cases, stroke is then the first clinical manifestation of previously unrecognized disease [22].

Importantly, stroke risk appears similar across atrial fibrillation types. Even short episodes may promote thrombus formation and increase thromboembolic risk [8] and therefore, early detection and appropriate risk assessment are essential regardless of type or symptom burden.

3.4 Risk Factors And Risk Assessment

3.4.1 Non-Modifiable Risk Factors

Age is one of the most important non-modifiable risk factors for stroke in patients with atrial fibrillation. Stroke risk increases significantly with age, particularly in individuals over 65 years and even more so after 75 years. This is associated with structural and functional changes in the cardiovascular system, including atrial fibrosis, endothelial dysfunction, and increased vascular stiffness [14, 2]. In addition, older patients more frequently present with comorbidities that further elevate thromboembolic risk.

Sex is another significant factor and studies indicate that women with atrial fibrillation may have a higher risk of stroke compared to men, especially in older age groups. This may be explained by biological differences, including hormonal influences and longer life expectancy in women [8]. Consequently, female sex is included as a component of the CHA_2DS_2-VASc score.

Genetic predisposition may also play a role in both the development of atrial fibrillation and susceptibility to thromboembolic complications. Evidence suggests that genetic factors can influence arrhythmia susceptibility and coagulation pathways; however, their clinical applicability remains limited and they are not routinely included in risk assessment [4].

It is also important to emphasize that non-modifiable risk factors often interact with modifiable ones, leading to a cumulative increase in stroke risk. Hence, their identification is essential for accurate risk stratification and appropriate preventive strategies.

3.4.2 Modifiable Risk Factors

Modifiable risk factors (listed below) play a crucial role in the development of thromboembolic complications in patients with atrial fibrillation, and their management is essential for effective stroke prevention.

- **Hypertension** is one of the most significant risk factors. It leads to structural cardiac changes, including left atrial enlargement and myocardial hypertrophy, and contributes to endothelial dysfunction and vascular stiffness, thereby promoting thrombogenesis [10].
- **Diabetes** significantly contributes to stroke risk through chronic hyperglycemia, which induces endothelial dysfunction, oxidative stress, and inflammation, all of which enhance thrombus formation [2].
- **Obesity** is a major contributor to both AF development and its complications. It is associated with systemic inflammation, metabolic disturbances, and structural cardiac remodeling. Weight reduction has been shown to reduce burden and improve clinical outcomes [18, 1].

- **Obstructive sleep apnea** is an often under recognized risk factor. It leads to intermittent hypoxia, sympathetic activation, and increased blood pressure, all of which contribute to AF and thromboembolic risk [8].
- **Lifestyle** factors are also critical. Smoking promotes endothelial damage, inflammation, and hypercoagulability. Excessive alcohol consumption may trigger AF episodes ("holiday heart syndrome") and increase thromboembolic risk. Physical inactivity contributes to obesity and metabolic dysfunction.
- **Heart failure** and coronary artery disease further increase thromboembolic risk through hemodynamic disturbances and structural cardiac changes [8].
- Importantly, **suboptimal control of risk factors and underuse of anticoagulation therapy** remain as major issues. Studies show that many patients with AF do not receive adequate treatment, increasing stroke risk [16].

Effective lifestyle modification, weight reduction, and appropriate management of comorbidities can significantly reduce stroke risk. Modern control of atrial fibrillation emphasizes on comprehensive risk factor control as a cornerstone of prevention.

3.4.3 Clinical Risk Assessment

In clinical practice, the CHA_2DS_2-VASc score is widely used to assess stroke risk in patients with atrial fibrillation and to guide anticoagulation therapy [14, 8]. The CHA_2DS_2-VASc score assigns points for the presence of specific risk factors, including:

- **C**ongestive heart failure (1 point),
- **H**ypertension (1 point),
- **A**ge ≥ 75 years (2 points),
- **D**iabetes (1 point),
- prior **S**troke or transient ischemic attack (2 points),
- **V**ascular disease (1 point),
- **A**ge 65–74 years (1 point),
- **S**ex: female (1 point).

The total score allows classification of patients into different risk categories. A score of 0 indicates low risk, whereas higher scores reflect progressively increasing stroke risk. Anticoagulation therapy is generally recommended for patients with a score ≥ 2 according to current clinical guidelines [8, 10].

At the same time, assessment of bleeding risk is essential and is commonly performed using the HAS-BLED score. This tool includes factors such as hypertension, renal and liver dysfunction, prior stroke, bleeding tendency, unstable INR, older age, and use of drugs or alcohol [19].

The combined use of these scores enables a comprehensive risk assessment and helps balance the benefits of anticoagulation against the potential risk of bleeding. Modern clinical practice emphasizes individualized treatment and regular reassessment of risk in patients with atrial fibrillation.

3.5 Prevention Strategies

Stroke prevention in patients with atrial fibrillation represents a fundamental component of modern clinical practice. Effective prevention requires an extensive and multifaceted approach that includes pharmacological therapy, lifestyle modification, management of comorbidities, and interventional procedures. This integrated strategy aims not only to reduce thromboembolic risk but also to improve overall cardiovascular outcomes and quality of life [8, 10].

3.5.1 Pharmacological Prevention

Anticoagulation therapy is the cornerstone of stroke prevention in patients with atrial fibrillation and significantly reduces the risk of thromboembolic events [7]. Two main groups of anticoagulants are used in clinical practice: vitamin K antagonists (VKAs), such as warfarin, and non-vitamin K oral anticoagulants (NOACs), including apixaban, rivaroxaban, dabigatran, and edoxaban.

VKAs are effective but have several limitations. They require regular monitoring of the international normalized ratio (INR), are associated with numerous drug and dietary interactions, and exhibit variable therapeutic responses. However, their advantages include applicability in patients with mechanical heart valves and the ability to directly monitor anticoagulation intensity.

NOACs offer a more predictable pharmacokinetic profile, shorter half-life, and do not require routine coagulation monitoring. Clinical trials have demonstrated that NOACs are at least as effective as warfarin in preventing stroke and are associated with a lower risk of intracranial bleeding [6,17,21]. However on the other

hand the management of stroke in patients receiving NOACs is an important clinical issue is. Unlike VKAs, which can be reversed with vitamin K, NOACs require specific reversal agents (e.g., idarucizumab for dabigatran), and their availability may be limited. Management decisions depend on the timing of the last dose and the patient's clinical condition [10].

Among NOACs, apixaban and rivaroxaban are widely used. Evidence suggests that apixaban may be associated with a lower risk of major bleeding while maintaining high efficacy, whereas rivaroxaban offers the advantage of once-daily dosing, potentially improving adherence. Therefore, treatment choice should be individualized. Bleeding risk assessment is essential and commonly performed using the HAS-BLED score, which helps identify high-risk patients and optimize therapy [19].

In addition to anticoagulation, pharmacological management of comorbidities plays a critical role in stroke prevention. Effective control of hypertension, diabetes, and heart failure reduces vascular damage, improves endothelial function, and decreases thromboembolic risk. A comprehensive therapeutic approach significantly improves patient outcomes [8, 2].

3.5.2 Lifestyle Modifications

Lifestyle modification is a fundamental component of stroke prevention in patients with AF and should be an integral part of comprehensive management.

Regular physical activity plays a crucial role in maintaining cardiovascular health. According to World Health Organization (WHO) recommendations, adults should engage in at least 150–300 minutes of moderate-intensity physical activity or 75–150 minutes of vigorous activity per week [24]. Moderate activities such as brisk walking, cycling, or swimming improves endothelial function, reduce inflammation, and enhance metabolic health. In patients with atrial fibrillation, regular moderate physical activity is generally safe and recommended, provided there are no contraindications. It has been shown to reduce atrial fibrillation burden and improve physical capacity and quality of life [18]. However, excessive endurance exercise may increase arrhythmia risk in some individuals and should be approached with caution.

Diet is another key factor in cardiovascular prevention. WHO recommends a diet rich in fruits, vegetables, whole grains, and legumes, with reduced intake of salt, sugar, and saturated fats [24]. The Mediterranean diet, in particular, has been associated with improved lipid profiles, reduced inflammation, and lower stroke risk [1]. Maintaining a healthy body weight is essential in atrial fibrillation management. Weight reduction in obese patients improves atrial function, reduces cardiac workload, and decreases AF episodes [13].

Alcohol consumption is an important modifiable factor. Excessive intake may trigger atrial fibrillation episodes and increase thromboembolic risk; therefore, limitation or abstinence is recommended. **Smoking** has well-established adverse cardiovascular effects, including endothelial damage, oxidative stress, inflammation, and increased coagulability, all contributing to higher thromboembolic risk.

Increasing attention is also being paid to **sleep quality and stress management**. Chronic stress and sleep disturbances can activate the sympathetic nervous system and promote inflammation. Obstructive sleep apnea is strongly associated with AF and stroke risk and should be appropriately managed [8].

In summary, lifestyle modification—including adherence to WHO physical activity recommendations, a healthy diet, weight control, and elimination of harmful habits—is essential in reducing stroke risk in patients with atrial fibrillation.

3.5.3 Interventional Strategies

Interventional strategies play an important role in the comprehensive management of patients with atrial fibrillation, particularly in cases where pharmacological therapy is ineffective or not well tolerated.

Catheter ablation is one of the most commonly used interventional procedures in atrial fibrillation management. Its primary goal is the isolation of arrhythmogenic foci, most often located within the pulmonary veins. The procedure involves the insertion of catheters into the heart via the venous system and the application of energy, typically radiofrequency or cryoenergy, to ablate the tissue responsible for initiating and maintaining the arrhythmia [20]. Catheter ablation is particularly recommended in patients with symptomatic AF who have not responded to or cannot tolerate antiarrhythmic drugs. In selected cases, it may also be considered as a first-line treatment, especially in younger patients with paroxysmal atrial fibrillation [8].

The effectiveness of ablation depends on the type of atrial fibrillation. Higher success rates are observed in patients with paroxysmal atrial fibrillation, whereas persistent and permanent AF is associated with lower success rates and often require repeat procedures. Importantly, although ablation improves rhythm control, it does not completely eliminate stroke risk, and anticoagulation therapy is often still required. As with any invasive procedure, catheter ablation carries potential risks, including cardiac tamponade, vascular

complications, and thromboembolic events. However, in experienced centers, complication rates remain relatively low.

Another important interventional option is left atrial appendage (LAA) closure. Since the majority of thrombi in atrial fibrillation originate in the left atrial appendage, its occlusion can significantly reduce stroke risk [23]. The procedure involves percutaneous implantation of a closure device via the femoral vein and transseptal access, typically under echocardiographic and fluoroscopic guidance. LAA closure is particularly indicated in patients with a high risk of stroke who have contraindications to long-term anticoagulation, such as an elevated bleeding risk [8]. Clinical trials have demonstrated that this approach may be an effective alternative to anticoagulation in appropriately selected patients [9].

In summary, interventional strategies represent an important complement to pharmacological treatment in atrial fibrillation patients. Careful patient selection and individualized therapy are essential to achieve optimal outcomes.

3.5.4 Integrated Care Approach

Modern management of atrial fibrillation is based on an integrated care model combining stroke prevention, symptom control, and management of comorbidities.

A key component of this approach is the ABC pathway, which includes:

A (Anticoagulation / Avoid stroke) – appropriate anticoagulation,

B (Better symptom control) – rate or rhythm control,

C (Cardiovascular risk and comorbidity management) – management of risk factors and comorbid conditions [8].

This model emphasizes individualized treatment and regular reassessment of patient risk. Its implementation has been associated with improved clinical outcomes and a reduced risk of cardiovascular complications, including stroke.

Patient education and adherence to therapy are also essential components of effective management.

3.6 Screening and Early Detection of Atrial Fibrillation

Early detection of atrial fibrillation plays a crucial role in stroke prevention, particularly in asymptomatic cases. A significant proportion of patients remain undiagnosed until serious complications such as stroke occur [22].

Screening programs are especially recommended in high-risk populations, including elderly individuals and patients with comorbidities. Simple methods such as pulse palpation and electrocardiography can be effective in detecting arrhythmias. In recent years, increasing attention has been given to modern technologies, including wearable devices such as smartwatches, which allow continuous heart rhythm monitoring. These technologies can detect atrial fibrillation episodes even in asymptomatic patients [5].

Patient education also plays an important role. Awareness of symptoms, risk factors, and the importance of regular check-ups facilitates earlier diagnosis and timely treatment. Early diagnosis enables prompt initiation of anticoagulation therapy, significantly reducing stroke risk. Therefore, the development of screening programs and the use of modern technologies represent important directions in public health.

3.7 Challenges And Limitations In Stroke Prevention In Atrial Fibrillation

Despite the availability of effective stroke prevention strategies in patients with atrial fibrillation, their implementation in clinical practice remains suboptimal. It is estimated that only about 50–60% of patients with atrial fibrillation receive appropriate anticoagulation therapy [16].

One of the main challenges is concern about bleeding complications, which may lead to underuse of anticoagulation, particularly in high-risk patients. Another important issue is under diagnosis of atrial fibrillation, especially in asymptomatic cases. Approximately 20–30% of patients are diagnosed only after experiencing a stroke, which significantly worsens prognosis [22]. Furthermore, up to 30–50% of stroke patients with atrial fibrillation had not received prior anticoagulation therapy, highlighting the importance of proper risk assessment and timely treatment. Adherence to therapy also remains a major challenge. Irregular medication use or discontinuation significantly increases thromboembolic risk. Finally, individualization of therapy represents an important clinical challenge, as balancing stroke risk against bleeding risk requires careful assessment and consideration of multiple patient-specific factors.

In summary, despite advances in atrial fibrillation management, significant limitations still affect the effectiveness of stroke prevention.

4. Discussion

The present literature review confirms that atrial fibrillation is one of the most important risk factors for stroke and represents a major and growing clinical challenge. The increasing prevalence of atrial fibrillation, driven primarily by population aging and the rising burden of chronic diseases, underscores the need for effective and comprehensive prevention strategies [8, 2].

Accurate stroke risk assessment remains a cornerstone of management. The CHA_2DS_2-VASc score enables identification of patients who require anticoagulation therapy, while the HAS-BLED score facilitates estimation of bleeding risk and supports a balanced therapeutic approach [14, 19]. The combined use of these tools is essential for individualized patient care.

Anticoagulation remains the most effective strategy for stroke prevention in atrial fibrillation. The introduction of non-vitamin K oral anticoagulants has significantly improved the safety and practicality of therapy [6, 17]. However, despite these advances, underuse of anticoagulation persists and continues to limit the overall effectiveness of prevention strategies.

Modifiable risk factors also play a central role. Effective control of hypertension, diabetes, obesity, and lifestyle-related factors has been shown to significantly reduce stroke risk, highlighting the importance of a multifactorial approach that combines pharmacological and non-pharmacological interventions [18, 13].

Particular attention should be given to asymptomatic atrial fibrillation. A substantial proportion of patients remain undiagnosed until a stroke occurs, which significantly worsens prognosis. In this context, screening programs and modern monitoring technologies may play a key role in improving early detection [22, 5].

Despite advances in treatment, several challenges remain, including underuse of anticoagulation, poor adherence to therapy, and the need for individualized decision-making that balances stroke and bleeding risks.

From a clinical perspective, emerging technologies such as wearable devices and mobile health applications offer promising opportunities for improving atrial fibrillation detection and long-term monitoring.

In summary, effective stroke prevention in atrial fibrillation requires an integrated approach that includes risk assessment, appropriate anticoagulation, management of modifiable risk factors, and early diagnosis. Further optimization of prevention strategies remains necessary to improve clinical outcomes.

5. Conclusions

Atrial fibrillation is a major risk factor for stroke and an increasing clinical challenge. Its growing prevalence underscores the importance of effective prevention strategies. Stroke risk is multifactorial, and its proper assessment using tools such as CHA_2DS_2-VASc and HAS-BLED enables more precise and individualized therapeutic decisions.

Anticoagulation remains the cornerstone of prevention, supported by effective management of comorbidities and lifestyle modification. Early detection, particularly in asymptomatic patients, is essential for reducing stroke risk and improving outcomes.

Overall, effective stroke prevention in atrial fibrillation requires an integrated approach combining risk assessment, appropriate treatment, and timely diagnosis.

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