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EFFECTS OF HYPERTENSION AND ATRIAL FIBRILLATION ON STROKE RISK

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ABSTRACT

BACKGROUND:

Arterial hypertension and atrial fibrillation (AF) are among the most significant modifiable risk factors for stroke. Their coexistence markedly increases the risk of cerebrovascular events and cognitive decline. Even high-normal blood pressure is associated with a higher likelihood of developing AF, and optimal control of blood pressure can reduce this risk, particularly in high-risk patients.

OBJECTIVE:

To summarize and critically analyze the relationship between arterial hypertension, atrial fibrillation, and stroke risk, with particular focus on prevention, early detection, and management strategies.

METHODS:

A narrative literature review was performed using PubMed, Embase, Scopus, Web of Science, and the Cochrane Library, along with the latest European Society of Cardiology (ESC) guidelines on hypertension and AF. The search covered publications from the last 10 years, using terms including "hypertension", "atrial fibrillation", "stroke risk", and "prevention". Inclusion criteria comprised clinical trials, population-based studies, systematic reviews, and major guidelines concerning adult populations. Studies with insufficient methodological data or involving non-human subjects were excluded.

RESULTS:

Population-based studies indicate that high-normal blood pressure increases the risk of developing AF by up to 60%, while the coexistence of hypertension and AF increases stroke risk more than fivefold compared to individuals without either factor [8]. Effective AF management should be comprehensive, such as the CARE model, and include early initiation of anticoagulation guided by the CHA_2DS_2-VASc score rather than arrhythmia type alone. Evidence supports the role of NOACs and catheter ablation in selected patients, although comparative advantages over pharmacological therapy are inconsistent. Early detection of silent AF in hypertensive patients and those with cryptogenic stroke is a key element of secondary prevention. Multi-domain lifestyle interventions, including dietary modification and physical activity, further reduce cardiovascular and cerebrovascular risk.

CONCLUSIONS:

Current evidence supports ESC guidelines emphasizing strict blood pressure control and comprehensive AF management as central components of stroke prevention. Identified knowledge gaps include insufficient data on optimal BP targets for AF prevention, limited evidence on the combined effect of intensive BP control and anticoagulation, and a lack of large-scale trials assessing early detection strategies for silent AF in hypertensive patients. Addressing these gaps could improve prevention strategies and reduce stroke incidence.

KEYWORDS:

Hypertension, atrial fibrillation, stroke risk, stroke prevention.

INTRODUCTION

HYPERTENSION – DEFINITION AND CLASSIFICATION ACCORDING TO THE ESC

This paper begins with the concept and definition of hypertension. Hypertension according to the 2024 guidelines as office hypertension is a systolic BP of ≥140 mm Hg or a diastolic BP of ≥90 mm Hg. In addition, there is a category of "elevated BP," which is defined as a systolic BP of 120-139 mm Hg or a diastolic BP between 70-89 mm Hg. Out-of-office measurement by HBPM or ABPM or repeat measurement in the doctor's office is recommended to make the diagnosis. The tables below present the blood pressure thresholds for each diagnostic category, including unhypertensive, elevated, and hypertensive blood pressure. [1]

Table 1. Classification of pressures according to their values [1].

Unhypertensive blood pressure (Fulfillment of both values - systolic and diastolic pressure)	Elevated blood pressure (Meeting a minimum of one systolic or diastolic pressure value)	Hypertension (Meeting a minimum of one systolic or diastolic blood pressure value)
Office measurement SBP < 120 mmHg DBP <70 mmHg	Office measurement SBP 120-139 mmHg DBP 70-89 mmHg	Office measurement SBP ≥140 mm Hg DBP ≥90 mm Hg
HBPM SBP <120 mmHg DBP <70 mmHg	,HBPM SBP 120-134 mmHg DBP 70-84 mmHg	HBPM SBP ≥135 mm Hg DBP ≥85 mm Hg
ABPM – day SBP <120 mmHg DBP < 70 mmHg	ABPM – day SBP 120-134 mmHg DBP 70-84 mmHg	ABPM – dzień SBP ≥135 mm Hg DBP ≥85 mm Hg

Hypertension is one of the most common chronic conditions. It plays an important role in the development of many serious comorbidities, such as stroke, myocardial infarction, heart failure and kidney failure. For the past hundred years, it has been one of the most studied disorders and a key topic in the medical literature[2]. A 2015 clinical study shows that hypertension therapy significantly reduces the risk of cardiovascular disease including stroke by 35-40%, myocardial infarction by 15-25% and heart failure by 64%. Observations show that the risk of cardiovascular disease increases progressively as systolic blood pressure exceeds 115 mm Hg. In contrast, the results of randomized controlled trials conducted among hypertensive patients confirm the effectiveness of treatment mainly when systolic blood pressure is achieved below 150 mm Hg.[3] Many therapies are present in the treatment of hypertension. The Precision Hypertension Care (PHYSIC) study

estimates that individually tailored therapy lowers systolic blood pressure by an average of 4.4 mm Hg more than treatment with a fixed regimen, which may have a positive effect on its later sequelae [4].

ATRIAL FIBRILLATION – DEFINITION AND PATHOMECHANISM

Atrial fibrillation is the most common form of cardiac arrhythmia and is one of the main risk factors for stroke. Risk factors for atrial fibrillation include advanced age, hypertension, heart and lung diseases, congenital heart defects and excessive alcohol consumption.Treatment options include anticoagulants, heart rate control drugs, heart rhythm control drugs, cardioversion, ablation and other cardiac procedures. It is the most common type of arrhythmia.Its cause is abnormal electrical activity in the atria of the heart.[11]

Treatment of atrial fibrillation according to the 2024 ESC Guidelines for the treatment of atrial fibrillation is mainly the acronym CARE where the different letters stand for abbreviations such as C-Control of comorbidities and risk factors A-Prevention of stroke and other thromboembolic events, R-Mitigation of symptoms by controlling rhythm and heart rate, E-Continuous evaluation and adjustment of treatment over time. [12] According to the CABANA clinical trial involving 2,204 patients with atrial fibrillation, transcatheter ablation compared to traditional drug treatment was shown to significantly improve quality of life after one year, as assessed by a special questionnaire on the impact of atrial fibrillation on daily functioning.[14] Ablation was found to be more effective than drug treatment in improving quality of life in both men and women, with the greatest benefit in those who had the lowest quality of life at baseline. [14]

STROKE – DEFINITION AND DIVISION

Stroke is one of the most common causes of death worldwide and a major factor leading to permanent disability. [15] Stroke is defined as a sudden-onset, focal or global neurological deficit resulting from acute damage to central nervous system structures of vascular etiology, including cerebral ischemic infarction, intracerebral hemorrhage (ICH) or subarachnoid hemorrhage (SAH).[16]

Despite extensive research, significant gaps remain in current knowledge. The long-term impact of high-normal blood pressure on stroke risk in patients with atrial fibrillation has not been fully elucidated. Evidence on the effectiveness of early detection methods for silent atrial fibrillation in hypertensive patients is limited, and no clear consensus exists regarding the optimal combination of antihypertensive and anticoagulant therapies to reduce stroke incidence across different patient populations. The aim of this review is to summarize and critically assess current evidence on the relationship between hypertension, atrial fibrillation, and stroke risk, with a focus on identifying the most effective diagnostic and preventive strategies for patients with both conditions.

FINDINGS AND DISCUSSION

MECHANISM OD CEREBRAL VASCULAR DUE TO HYPERTENSION

Chronic elevation of blood pressure, especially high blood pressure, can lead to an increase in pulse wave velocity (PWV), which is an important indicator of arterial stiffness. Arterial stiffness is considered a potential biomarker of stroke risk because of its association with deterioration of vascular function. [5] There is some controversy over whether hypertension is a cause or a consequence of central arterial stiffness [6].

Elevated systolic blood pressure - SBP and diastolic blood pressure - DBP are associated with a decrease in both global and local cerebral blood flow. People with hypertension are most often reported to have reduced blood flow in areas such as the prefrontal cortex, anterior cingulate, occipital lobe and right cerebral hemisphere. Men and the elderly are particularly susceptible to blood supply disorders caused by hypertension. Studies have shown that the prefrontal cortex is one of the brain areas most vulnerable to the negative consequences of hypertension. People with hypertension are found to have both a reduction in white matter volume and a higher incidence of white matter hyperintensities in this region compared to people with normal blood pressure.[7]

According to the SPRINT trial, among patients at high cardiovascular risk but without diabetes, intensive treatment aimed at lowering systolic blood pressure below 120 mm Hg, compared to the standard goal of below 140 mm Hg, was associated with a reduction in major cardiovascular incidents (both fatal and nonfatal) and a reduction in overall mortality. However, it should be noted that some adverse effects were more common in the intensive treatment group. [3]

ASSOCIATION OF HYPERTENSION WITH ATRIAL FIBRILLATION

Hypertension is one of the key risk factors for developing atrial fibrillation or atrial flutter. Nearly 60% of patients with atrial fibrillation have hypertension, and higher blood pressure is associated with a higher risk of

developing this arrhythmia. [8] Recent studies have shown that even higher limits of normal systolic blood pressure (SBP) are associated with an increased long-term risk of developing atrial fibrillation. Although not all studies agree, with some suggesting that lowering blood pressure (BP) may help reduce the risk of new AF [9]. According to the Multi-Ethnic Study of Atherosclerosis, both prehypertension and hypertension were associated with an increased risk of developing atrial fibrillation compared to those with optimal blood pressure values. [10]

EFFECT OF ATRIAL FIBRILLATION ON STROKE

Atrial fibrillation (AF) is now considered an indicator of atrial cardiomyopathy, which leads to a prothrombotic state by various mechanisms. The classification of AF is based on the duration of the rhythm, reflecting that patients initially experience episodes of short duration that become longer over the course of the disease due to structural changes in the atria. A study whose endpoint was the incidence rate of ischemic stroke showed that it is the thromboembolic risk profile that influences the need for anticoagulant treatment, not the type of AF. The study included 5917 patients 1361 in the real world and 4556 in clinical trials. Stroke risk was assessed using the CHA2DS2-VASc scale and the CARS scale. An additional parameter was found to be a c-score of non-proximal AF. [20] Therefore, it is important to start treatment early enough. A post hoc analysis of the ELAN trial, involving 1966 patients, estimated that early treatment with oral anticoagulants could lead to a benefit of about 2 prevented events per 100 patients, although there is a possibility that this benefit would be minimal or not occur at all. The main indicator was the NCB comparing early treatment with later treatment, calculated as the difference between the number of prevented ischemic events - recurrent stroke, embolism and excess bleeding events of major bleeding. The analysis considered prevented events within 30 days or 90 days. Of the original participants in the 2013 ELAN study, 1966 were eligible for analysis. Of these participants, 977 (49.7%) were assigned to the early oral anticoagulant treatment (DOAC) group and 989 (50.3%) to the later treatment group. The median age was 77 years, and 1075 participants (54.7%) were men. [21] The early use of AF ablation in patients primarily taking non-antagonist oral anticoagulants to vitamin K (NOACs) was associated with prolonged survival compared to treatment based on pharmacotherapy alone.[18]

No significant prognostic differences were observed between treatment with catheter ablation and drug therapy for either primary or major secondary endpoints, regardless of the type of AF. Table 2 presents the differences in net clinical benefit (NCB) between early and late treatment at 30 and 90 days. [19]

Table 2. NCB – Impact of early vs. late treatment (30 and 90 days) [21].

While	Type of treatment	NCB average (events per 100 participants)	Confidence interval (95% CI)
30 days	Early treatment	1,73	(0,06) - (3,40)
	Late treatment	1,72	(-0,63) - (3,98)
90 days	Early treatment	2,16	(0,30) - (3,87)
	Late treatment	2,14	(-0,26) - (4,41)

CHA2DS2-VASC SCALE AND STROKE RISK ASSESSMENT.

Patient health education has an important impact here. Based on the IMPACT-AFib Randomized Clinical Trial, a distributed database of health plan members was used to identify patients with atrial fibrillation, a CHA_2DS_2-VASc score of ≥2, no prescription of anticoagulants (OACs) in the past 12 months and no bleeding requiring hospitalization in the past 6 months. Conducting a one-time educational intervention targeting AF patients and their physicians was not associated with a statistically significant increase in the rate of initiation of oral anticoagulant therapy. These findings underscore the need to implement more complex, multistage or more intensive intervention strategies to effectively increase the use of anticoagulant therapy, which plays a key role in stroke prevention in this patient population.[22] It is therefore important to implement appropriate technology. In the mAFA-II study, which was a prospective cluster randomized trial, atrial fibrillation patients who used mobile health (mHealth) technology to support the ABC pathway (A: use of anticoagulant treatment, B: improved symptom control, C: management of comorbidities) experienced a significant reduction in stroke risk, death and re-hospitalization, compared to those who received standard care.[23]

The CHA2DS2-VASc score is a key element in assessing the risk of stroke in patients with atrial fibrillation.

Stroke risk factors can be modified later in life. The MISOAC-AF trial involved an observational analysis of 1127 patients with AF. The risk of stroke in patients with AF changed over time, as shown by changes in CHA2DS2-VASc scale scores. Most patients who suffered an ischemic stroke had new comorbidities. Changes in scores and the Delta CHA2DS2-VASc value (CHA2DS2-VASc over time) better predicted incident stroke. This underscores the variability of risk as patients age and acquire new risk factors. This underscores the need for systematic evaluation of patients with AF. [24]

SYNERGISM OF HYPERTENSION AND ATRIAL FIBRILLATION IN THE DEVELOPMENT ON STROKE.

Some patients who have had an embolic stroke of unknown source may be found to have silent atrial fibrillation (AF) or develop AF after the initial diagnosis. A more thorough understanding of AF risk factors is important for implementing more effective monitoring methods that can prevent recurrent strokes resulting from previously undetected AF. In the RE-SPECT ESUS study, multivariate analysis was performed, which showed that independent predictors of AF development during follow-up included advanced age , the presence of hypertension , diabetes and higher body mass index. In addition to age, which proved to be the strongest risk factor, other parameters such as hypertension, elevated BMI and the absence of diabetes independently correlate with the occurrence of AF after cryptogenic stroke. These factors are significant predictors of AF, which in turn is associated with a higher risk of stroke. [25]

Hypertension is considered one of the major risk factors for atrial fibrillation (AF) and stroke. The LOOP study, which included people between the ages of 70 and 90, found that while participants did not have prior AF, they had other risk factors for stroke. Participants were randomly assigned to two groups: one that underwent screening with an implantable loop recorder (ILR), initiating anticoagulant treatment after detecting AF episodes lasting at least 6 minutes, and another that received standard care.[26] An implantable loop recorder (ILR), which enables continuous electrocardiographic recording, can significantly aid in identifying asymptomatic episodes of atrial fibrillation. The use of ILRs in screening has resulted in a threefold increase in arrhythmia detection and more frequent implementation of anticoagulation therapy. [27]A post hoc analysis of the randomized LOOP trial, involving 6004 high-risk stroke patients, including 1056 with a history of stroke, found that screening with an implantable loop recorder did not lead to a significant reduction in the rate of severe or fatal strokes compared with standard care, either in the overall study population or in the subgroup with prior stroke.[17] The study included 5997 participants whose systolic blood pressure (SBP) was measured at baseline. The analysis of the results was based on a Cox model that took into account the time to the first event and the causes of the event, which allowed us to assess the influence of various factors, including blood pressure, on the development of atrial fibrillation and the increased likelihood of stroke. As blood pressure increases, the impact of atrial fibrillation screening on thromboembolic events including stroke increases. Systolic blood pressure equal to and above 150 mmHg is associated with a 1.5-fold increase in the risk of atrial fibrillation episodes ≥24 hours and a reduction in ischemic events as part of the primary outcome in participants with SBP ≥150 mm Hg on ILR screening.[26]

STROKE PREVENTION

According to the FINGER study, which enrolled 1,259 people aged 66-70 years, evaluated the effect of a two-year multi-domain intervention-including diet, physical and cognitive activity, and vascular monitoring and health counseling-on the prevention of cardiovascular disease.The intervention group had a lower incidence of cerebrovascular incidents compared to the control group.[28] Statins play a key role in the primary prevention of CVD. The STAREE trial, one of the largest in the field, is evaluating the effects of statins on cardiovascular events, cognitive function and disability-free living in older adults. Its broad cohort provides high external validity of the results. [29]

Low physical activity and unhealthy diet are key independent risk factors for stroke, also affecting hypertension, dyslipidemia and obesity. International guidelines recommend improving these to reduce the risk of recurrent stroke. Exercise and nutrition programs implemented remotely are safe, feasible and can reduce important stroke risk factors. Further studies are required to assess the feasibility of implementing them on a larger scale and in more diverse populations.[30]

LIMITATIONS AND PERSPECTIVES

The interplay between hypertension and atrial fibrillation in determining stroke risk has been investigated in numerous studies; however, reported outcomes vary depending on study design, population characteristics, and definitions used. Differences in conclusions between trials comparing intensive and standard blood pressure control, as well as variability in reported benefits of early anticoagulation, illustrate the complexity of translating evidence into clinical practice. This highlights the need to individualize management strategies based on patient risk profiles and comorbidities. This review was based on literature retrieved from the PubMed

database and on the European Society of Cardiology guidelines. Expanding the search to include other databases and a wider range of sources could provide a more comprehensive evidence base. Further studies, including randomized controlled trials in diverse populations, are needed to refine diagnostic pathways and improve preventive strategies.

CONCLUSIONS

Arterial hypertension and atrial fibrillation are key modifiable risk factors for stroke,

each contributing to cerebrovascular damage and cognitive decline. Their coexistence significantly increases stroke risk. Effective, individualized blood pressure control and early anticoagulation based on risk assessment can substantially reduce this risk.

A comprehensive approach to atrial fibrillation management, including lifestyle modification, early detection, and appropriate use of NOACs or ablation in selected cases, is essential. Regular reassessment using the CHA_2DS_2-VASc score remains crucial.

There is a need for further research on optimal blood pressure targets, combined treatment strategies, and early detection of silent atrial fibrillation, especially in hypertensive patients. These findings align with current ESC guidelines emphasizing integrated prevention strategies.

DISCLOSURE

AUTHOR'S CONTRIBUTION

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USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence tools (e.g., ChatGPT, OpenAI) were used to assist with language editing, structural refinement, and the formulation of selected textual segments (e.g., background synthesis, objectives, conclusions). All AI-assisted content was critically reviewed, fact-checked, and finalized by the authors.

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CONFLICTS OF INTERESTS

The authors declare no conflict of interest.

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