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Cardioembolic Stroke in Elderly Patients: Risk Factors, Etiologies, and Therapeutic Approaches at Bar-le-Duc Fains-Véel Hospital Center in France – A Cross-Sectional Analysis

Accident vasculaire cérébral cardio-embolique chez les patients âgés : facteurs de risque, étiologies et approches thérapeutiques au Centre Hospitalier Bar-le-Duc Fains-Véel en France – Une analyse transversale

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Résumé

Contexte & objectif. L'accident vasculaire cérébral cardioembolique (AVC-C) est un sous-type majeur d'AVC ischémique chez le sujet âgé, fréquemment lié à la fibrillation atriale (FA) et à la cardiomyopathie dilatée (CMD). L'identification précoce des facteurs de risque et la mise en place de stratégies thérapeutiques personnalisées sont essentielles pour une prise en charge optimale. *Méthodes.* Une analyse rétrospective d'une série descriptive de patients âgés hospitalisés pour AVC cardioembolique a été réalisée aux départements de Cardiologie et de Neurologie du Centre Hospitalier Bar-le-Duc Fains-Véel en France. Les données ont été extraites des dossiers médicaux et analysées avec Stata 15.0. Les variables étudiées comprenaient les caractéristiques sociodémographiques, les antécédents médicaux, les signes cliniques, les étiologies cardioemboliques, les données paracliniques et les traitements. *Résultats.* Un total de 100 patients ont été finalement retenus pour l'étude. L'âge médian était de 74 ans, les femmes étant significativement plus âgées que les hommes (p = 0,003). Les comorbidités les plus fréquentes étaient l'hypertension artérielle, la dyslipidémie et le diabète de type 2. La FA et la CMD constituaient les principales étiologies. Des anticoagulants oraux directs ont été prescrits dans la grande majorité des cas, et la mortalité était faible. *Conclusion.* Chez le sujet âgé, l'AVC cardioembolique est principalement lié à la FA et à la CMD. Une prise en charge efficace repose sur une anticoagulation adaptée et, dans des cas sélectionnés, sur des stratégies de revascularisation.

Mots-clés : AVC cardioembolique, Fibrillation auriculaire, cardiomyopathie dilatée, prise en charge efficace
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Summary

Context and objectif. Cardioembolic stroke (CES) is a leading subtype of ischemic stroke in elderly, frequently linked to atrial fibrillation (AFib) and dilated cardiomyopathy (DCM). Timely risk factor identification and personalized therapeutic strategies are essential for optimal management. *Methods*. A retrospective analysis of a descriptive series of stroke cases involving elderly patients hospitalized for cardioembolic stroke was conducted in the Cardiology and Neurology Departments of the Bar-le-Duc Fains-Véel Hospital Center, France. Data were extracted from medical records and analyzed using Stata 15.0. Variables included sociodemographic characteristics, medical history, clinical signs, cardioembolic etiologies, paraclinical findings, and treatments. *Results***.** A total of 100 elderly patients were included in the study. Their median age was 74 years, with women being significantly older than men (p=0.003). The most common comorbidities included hypertension (75%), dyslipidemia (54%), and type-2 diabetes (24%). AFib (58.3%) and DCM (35%) emerged as the primary etiologies. Direct oral anticoagulants were prescribed in 85% of cases, the mortality rate was 3%. *Conclusion***.** CES in the elderly are mainly caused by AFib and DCM. Effective management relies on appropriate anticoagulation and, in selected cases, revascularization.

Keywords: cardiometabolic stroke, atrial fibrillation, dilated cardiomyopathy, therapeutic strategic
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Introduction

Ischemic stroke is a major cause of morbi-mortality worldwide, with the cardioembolic subtype being particularly prevalent among the elderly (1). This form of stroke results from cerebral embolism due to underlying cardiac issues, such as atrial fibrillation (Afib), cardiomyopathy, and valvular heart disease (2). As the elderly population continues to grow in developed countries, they remain especially vulnerable to cardioembolic stroke (CES). These strokes account for approximately 14% to 30% of cerebral infarctions and are associated with increased severity and higher in-hospital mortality compared to other stroke types (3). Individuals over 85 are particularly at risk of early embolic recurrence and often experience limited functional recovery (4). A study by Carbajo-García *et al.* focusing on patients over 85 identified specific predictive factors for CES in this age group: female sex, heart failure, and infectious complications. These findings emphasize the distinct clinical profile of the very elderly, underscoring the need for tailored diagnostic and therapeutic approaches (5).

Data from the Dijon stroke registry in France showed that strokes in older adults are associated with greater severity, a high prevalence of pre-existing cognitive impairment, and poorer functional outcomes. Among patients aged over 75, cardioembolic stroke emerged as the leading cause (6).

Despite the growing importance of understanding this issue, studies specifically targeting the epidemiological and clinical profiles of cardioembolic stroke in the elderly are still limited. A deeper understanding of its characteristics could enhance prevention, diagnosis, and management strategies (7).

Therefore, this study aimed to identify cardiovascular risk factors associated with CES and assess the frequency of various cardioembolic etiologies, such as AFib and cardiomyopathy. Additionally, it sought to analyze therapeutic approaches, including anticoagulation, thrombolysis, and thrombectomy, and investigate prognostic factors related to in-hospital outcomes like mortality and complications.

Methods

Study design, setting and period

This cross-sectional analytical study was conducted at the Cardiology and Neurology Departments of the Bar-le-Duc Fains-Véel Hospital Center, the primary healthcare provider for the residents in southern Meuse, located in the France's Grand-Est region. The study spanned a 12-month period, from January 2023 to January 2024.

Study participants and sampling

Data collection was comprehensive, utilizing the Hospital Manager software to extract information from electronic medical records. To be included, participants must be aged 65 or older, have ischemic stroke confirmed by CT or MRI, cardioembolic etiology established per TOAST classification, and possess complete, accessible medical records. Patients with hemorrhagic stroke, non-cardioembolic ischemic stroke, under 65 years, lacking etiological confirmation, or those refusing participation or with missing data are excluded.

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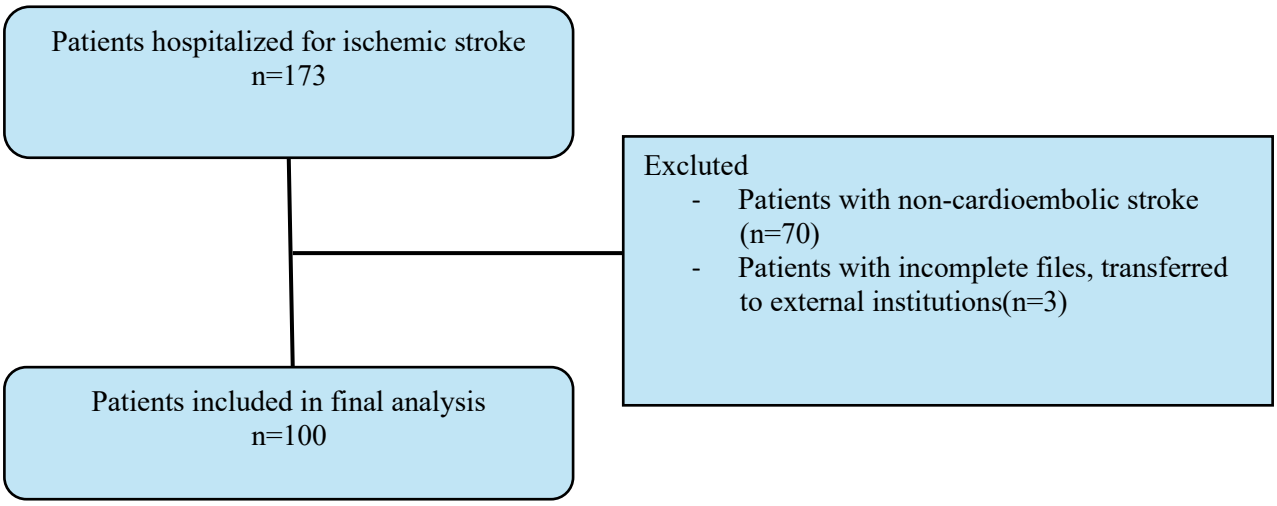

Figure 1. Participant flowchart

Data Collection

Data were collected using ad hoc questionnaire that included various parameters: sociodemographic factors (such as age, sex, occupation, ethnicity, smoking, alcohol use), clinical signs (including coma, paresis, paralysis, speech disturbance), comorbidities (like hypertension, type-2 diabetes, dyslipidemia, obesity, sleep obstructive apnea syndrome, chronic kidney disease(CKD), and information on electrocardiography (ECG) and echocardiographic assessments (both transthoracic [TTE] and transesophageal [TOE]). Additionally, therapeutic interventions were documented, covering the use of direct oral anticoagulants (DOACs), vitamin K antagonists (VKAs), thrombolysis, mechanical thrombectomy (MT), and combined thrombolysis-thrombectomy procedures. For detecting intra-atrial thrombus and measuring LVEF, we employed TEE or TOE, while brain imaging techniques, such as MRI and cerebral CT scans, were utilized to identify CES.

Operational definitions

Reduced LVEF is defined as less than 40%, while an LVEF of 40% or higher is considered mildly preserved and preserved. LA is dilated if ≥ 20 cm². AFib is identified through continuous cardiac monitoring, surface ECG, or Holter ECG, characterized by complete arrhythmia and the absence of organized atrial activity. Persistent foramen oval (PFO) is detected using TTE or TOE with a bubble study, indicated by more than five microbubbles passing through, and/or by transcranial Doppler. Moreover, DCM involves pathological dilation and impaired contraction of one or both ventricles, not explained by abnormal loading conditions or coronary artery disease. Furthermore, infectious endocarditis (IE) is defined by the presence of valvular vegetations associated with stroke occurrences. Likewise, CKD is characterized by kidney damage and/or a decreased glomerular filtration rate (GFR) of less than 60 mL/min/1.73 m² for over three months. DOACs are oral anticoagulants that directly inhibit thrombin or factor Xa. Conversely. VKAs are oral anticoagulants that inhibit the synthesis of vitamin K–dependent clotting factors. Thrombolysis involves administering a potent fibrinolytic agent to dissolve a thrombus, occluding a cerebral vessel during an acute ischemic stroke. Mechanical thrombectomy (MT) is a minimally invasive endovascular procedure used to remove thromboembolic occlusions from large cerebral arteries in patients with acute ischemic stroke. It involves the insertion of a catheter-based device through the vascular system to physically extract the clot, typically within a therapeutic window of up to 24 hours from symptom onset. This intervention is primarily indicated in cases of large vessel occlusion (LVO), including cardioembolic strokes, and is performed in specialized stroke centers with neurointerventional capabilities. The TOAST classification (Trial of Org 10172 in Acute Stroke Treatment) is a standardized system for categorizing ischemic stroke into five etiological subtypes—large-artery atherosclerosis, cardioembolism, small-vessel occlusion, other determined etiology, and undetermined etiology—based on clinical, imaging, and diagnostic criteria.

Statistical analysis

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The data were entered into Excel (Microsoft Corporation, USA, 2013) and analyzed using Stata software version 15.0 (StataCorp, Texas, USA, 2017). Results were expressed as counts (n), percentages (%), and measures of central tendency (mean, median) and dispersion (standard deviation, minimum, maximum, interquartile range) with normality assessed by Kolmogorov-Smirnov test.

Mean comparisons were performed using Student's t-test; in cases of variance heterogeneity, the Mann-Whitney U test was used to compare medians. Proportions were compared using Pearson's Chi-square test or Fisher's exact test when expected cell counts were < 5. The threshold for statistical significance was set at $\alpha<0,05$.

Ethical considerations

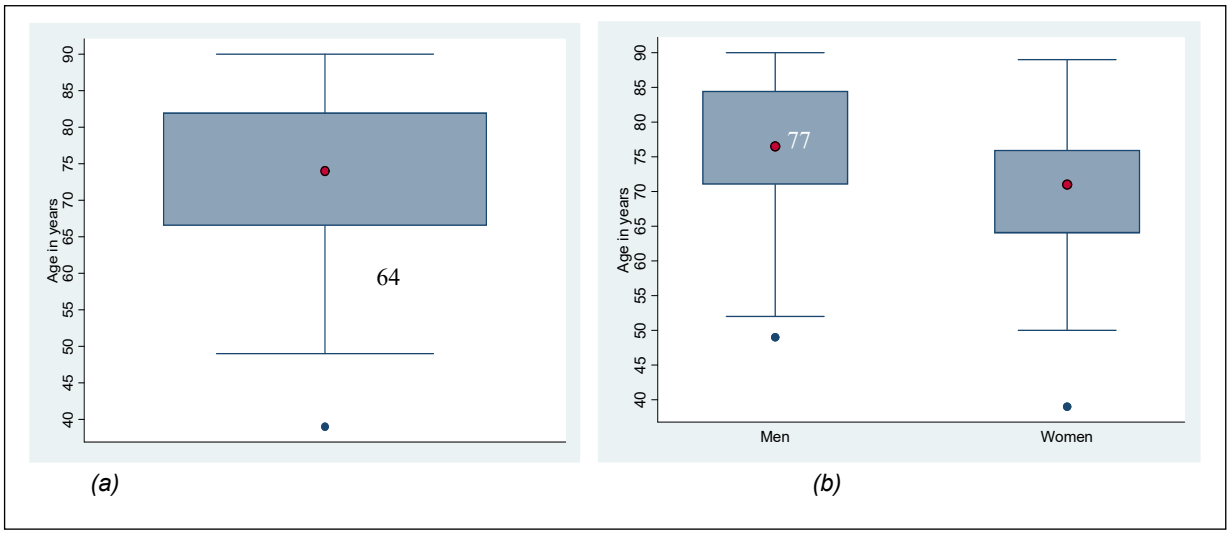
The study adhered to the ethical principles of the Declaration of Helsinki. Informed consent was obtained from patients or their legal representatives as needed. Ethical approval was requested and obtained from the ethics committee of the GHT Cœur Grand-Est, overseeing the Bar-le-Duc Hospital Center.

Results

In this study, we analyzed various parameters associated with CES in elderly patients.

Sociodemographic characteristics of the study population

The participants had a median age of 74 years. Women were older than men with an average age of 77 years compared to 71 years for men. This difference was statistically significant with a p-value of 0.003, indicating a meaningful disparity in age distribution between genders (Figure 2).



The study population was predominantly composed of males (52%). Individuals aged 75 years and older

represented the majority (51.0%), with men accounting for a significant portion of this group (61.5%). Conversely, women were prevalent in the under 75 age group accounting for 60.4%. These differences in age distribution by gender were statistically significant ($p < 0.05$). Additionally, most participants were retired (61.0%) and Caucasians (94.0%). No significant sex differences were observed ($p > 0.05$, table 1).

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Table 1. Sociodemographic characteristics of the participants according to the gender

Variable	All (n=100)	Male (n=52)	Female (n=48)	p-value
Age group				
< 75 years	49 (49.0)	20 (38.5)	29 (60.4)	0.028
≥ 75 years	51 (51.0)	32 (61.5)	19 (39.6)	
Occupation				
Office work	19 (19.0)	9 (17.3)	10 (20.8)	0.653
Education	1 (1.0)	1 (1.9)	0 (0.0)	1.000
Healthcare	1 (1.0)	1 (1.9)	0 (0.0)	1.000
Retired	61 (61.0)	26 (50.0)	35 (72.9)	0.019
Manual labor	18 (18.0)	15 (28.9)	3 (6.3%	0.004
Ethnicity				
African-American	6 (6.0)	2 (3.9)	4 (8.3)	0.423
Caucasian	94 (94.0)	50 (96.2)	44 (91.7)	

Note. Data are expressed as relative frequency (percent)

Clinical and paraclinical characteristics of the study population

Hypertension was the most frequently reported comorbidity in the study participants, affecting 75.0% of them, followed by dyslipidemia at 54.0%. Regarding clinical presentation, paresis and speech disturbances were the most commonly observed symptoms, occurring in 83.0% and 82.0% of cases, respectively. Notably, there were no statistically significant differences between genders across all these variables ($p > 0.05$, table 2.)

Table 2. Medical History and Clinical Signs in Patients with Cardioembolic Stroke

Variable	All (n=100)	Male (n=52)	Female (n=48)	p-value
Hypertension	75 (75.0)	40 (76.9)	35 (72.9)	0.644
Diabetes mellitus	24 (24.0)	12 (23.1)	12 (25.0)	0.822
Dyslipidemia	54 (54.0)	28 (53.9)	26 (54.2)	0.974
Smoking	22 (22.0)	13 (25.0)	9 (18.8)	0.451
Obesity	9 (9.0)	4 (7.7)	5 (10.4)	0.734
Alcohol use	6 (6.0)	3 (5.8)	3 (6.3)	1.000
SAOS	8 (8.0)	2 (3.9)	6 (12.5)	0.149
Chronic kidney disease	16 (16.0)	11 (21.2)	5 (10.4)	0.143
Coma	4 (4.0)	3 (5.8)	1 (2.1)	0.347
Paresis	83 (83.0)	41 (78.9)	42 (87.5)	0.250
Paralysis	13 (13.0)	9 (17.3)	4 (8.3)	0.239
Speech disturbance	82 (82.0)	43 (82.7)	39 (81.3)	0.851

Note. Data are expressed as relative frequency (percent). Abbreviations: SAOS = sleep obstructive apnea syndrome.

AFib was the most frequently observed etiology of cardioembolic stroke, accounting for 58.3% of cases in the overall population. This was followed by DCM, which accounted for 35.0% of cases. Specifically, among men, AFib and DCM were responsible for 53.8% and 39.3% of cases, respectively. Among women, these figures were 62.5% for AFib and 31.3% for dilated cardiomyopathy (Figure 3.)

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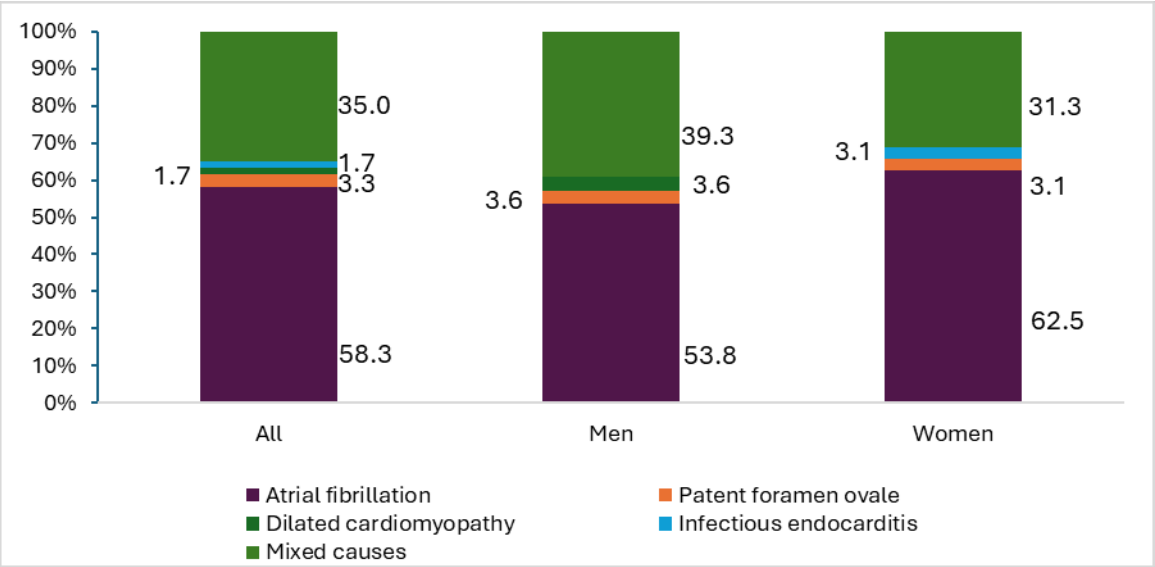

Figure 3. Distribution of cardioembolic stroke etiologies in the general population and by sex.

The mean LVEF in the overall population was 56.6%, with men exhibiting a significantly higher LVEF than women (58.1% vs. 54.9%; $p< 0.05$). The average size of left atrial was 23.3 cm². Most patients had a left atrial size ≥ 20 cm² (77.0%) and an ejection fraction ≥ 40%. A LV thrombus was present in 4.0% of cases, and 9.0% of patients had a pacemaker. The most common sites of cardioembolic stroke were the middle and anterior cerebral arteries (55.0%), followed by multifocal involvement in 34.0% of cases, table 3.)

Table 3. Echocardiographic and brain imaging characteristics of patients with cardioembolic stroke

Variables	All (n=100)	Male (n=52)	Female (n=48)	p-value
Left atrial size (cm²)	23.3 ± 0.5	22.9 ± 0.7	23.6 ± 0.7	0.236
Dilated LA	77 (77.0)	39 (75.0)	38 (79.2)	0.621
LVEF (%)	56.6 ± 0.8	58.1 ± 1.0	54.9 ± 1.3	0.023
Reduced LVEF	4 (4.0)	1 (1.9)	3 (6.3)	0.348
LV thrombus	4 (4.0)	2 (3.9)	2 (4.2)	1.000
Pacemaker	9 (9.0)	5 (9.6)	4 (8.3)	1.000
Brain imaging location				
MCA/ACA	55 (55.0)	26 (50.0)	29 (60.4)	0.296
Cerebellar/Pontine	11 (11.0)	7 (13.5)	4 (8.3)	0.529
Multi-territory	34 (34.0)	19 (36.5)	15 (31.3)	

Note. Data are expressed as mean ± SD, or relative frequency (percent). Abbreviations: LA, left atrial; LVEF, left ventricular ejection fraction; LV, left ventricle; ACA, anterior cerebral artery; MCA, middle cerebral artery.

Therapeutic Approaches and Clinical Outcomes in Patients with Cardioembolic Stroke

The majority of patients were treated with DOACs, comprising 85.0% of the group, while nearly 1 over 10 received VKAs. Intravenous thrombolysis was administered in 43.0% of cases, and MT was conducted in 4.0%. Notably, thrombolysis failure, which necessitated rescue thrombectomy occurred in 9.0% of cases (table 4.)

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Table 4. Therapeutic modalities used in patients with cardioembolic stroke

Variables	All	Men	Women	p-value
DOACs	85 (85.0)	46 (88.5)	39 (81.3)	0.313
AVK	9 (9.0)	3 (5.8)	6 (12.5)	0.305
Thrombolysis	43 (43.0)	22 (42.3)	21 (43.8)	0.884
Thrombectomy	4 (4.0)	1 (1.9)	3 (6.3)	0.348
Thrombolysis-thrombectomy	9 (9.0)	7 (13.5)	2 (4.2)	0.163

Note. Data are expressed as relative frequency (percent). Abbreviations: AVK, antivitamin K; DOACs, direct oral anticoagulants

Death among patients with CES was observed in 3 out of 100 individuals included in the study (Figure 4.)

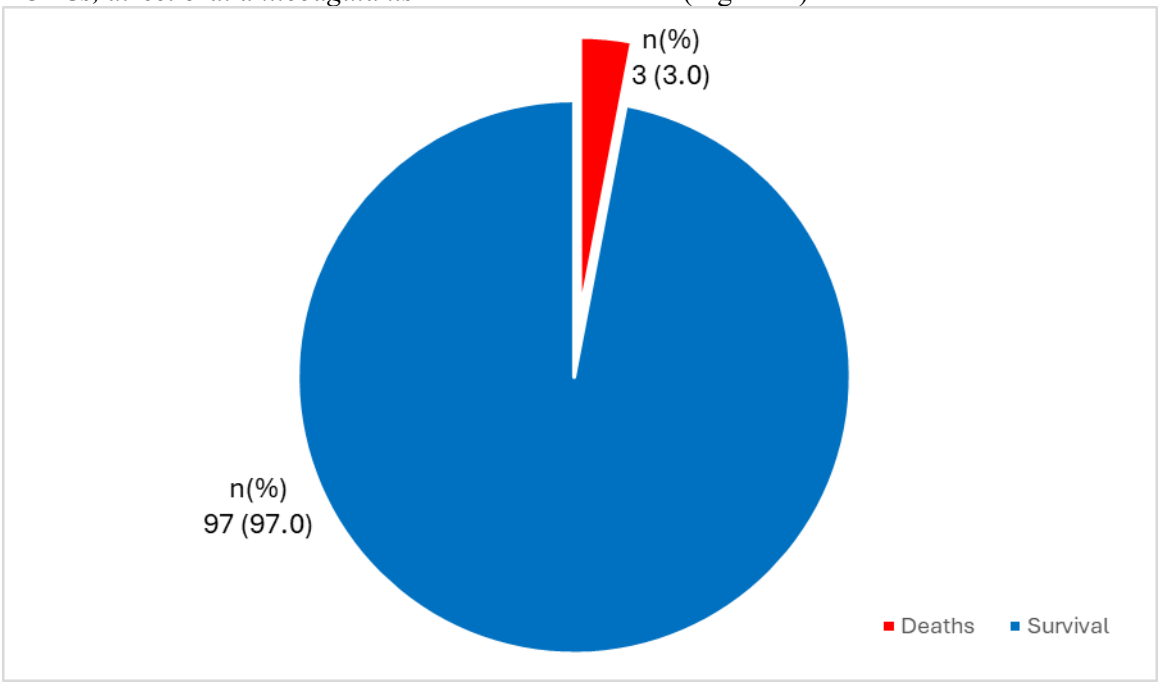

Figure 4. Death in patients with cardioembolic stroke.

Discussion

This study aims to unravel CES by identifying risk factors, etiologies, and effective therapies while exploring prognostic outcomes. Among traditional risk factors, we found that hypertension, obesity, smoking, and dyslipidemia were prevalent among individuals with CES. Additionally, our results indicate that CES was associated with AFib, heart failure, or a history of valvular disease.

Sociodemographic characteristics

The median age of the patients was 74 years. Women were significantly older than men, with ages averaging 77 compared to 71 years (p = 0.003), aligning with existing literature on female longevity and the higher incidence of stroke in older women (4,5). Ageing significantly increases the risk of CES through several interconnected biological and clinical pathways: AFib and structural cardiac changes, vascular ageing and endothelial dysfunction, comorbidities, amplified by age, impaired hemostasis and coagulation, reduce cerebral reserve and repair capacity. Several studies have highlighted the links between ageing and CES, particularly regarding cardiac and vascular alterations (3).

Comorbidities

Hypertension was the most common risk factor (75%), followed by dyslipidemia (54%) and type-2 diabetes (24%). These findings are consistent with previous studies identifying hypertension as the leading risk factor for stroke in older adults (7–9). The mechanisms involved include age-related vascular alterations, oxidative stress, chronic inflammation, and arterial stiffness (10-12).

Cardioembolic etiologies

AFib was the leading etiology (58.3%) of CES, reinforcing its central role, as demonstrated in

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several multicenter studies (13-16). AFib is consistently identified as the primary cause of CES, in alignment with ESC guidelines and the findings by Hart et al. (3). It is the most common sustained cardiac arrhythmia and a well-established source of cerebral embolism. Stasis, endothelial injury, and hypercoagulability which characterize Afib may foster a prothrombotic environment, facilitating thrombus formation that may embolize to cerebral arteries and result in ischemic stroke (9). DCM accounted for 35% of the etiologies in our study, with a male predominance (39.3%). It is associated with LV dilation and systolic dysfunction, promoting blood stasis and the formation of intracardiac thrombi. DCM is also associated with a prothrombotic atrial substrate, capable of generating emboli even in the absence of AFib. This phenomenon is increasingly attributed to atrial cardiopathy, characterized by structural remodeling, fibrosis, and impaired atrial contractility, which predispose to thrombus formation and embolic stroke (17-18, 29,30). Even with preserved ejection fraction (LVEF ≥ 40% in 96% of cases), LA enlargement (77% of patients) serves as a marker of cardiac embolism (11, 19). A meta-analysis of six prospective cohort studies involving over 66,000 participants demonstrated that LA enlargement was associated with a 68% increased risk of stroke compared to controls (adjusted HR 1.68; 95% CI: 1.36–2.07) (1). A PFO was identified in 3.3% of patients. Although its prevalence is relatively low in this elderly population, its role in CES should not be underestimated, particularly in cases classified as cryptogenic. PFO enables the paradoxical embolization of venous thrombi into the cerebral circulation via a right-to-left shunt. The embolic risk is amplified in the presence of an atrial septal aneurysm or a large shunt, as emphasized in recent reviews on PFO management (10). In older adults, percutaneous PFO closure remains a subject of debate but may be considered after multidisciplinary evaluation, especially when no other plausible embolic source is identified. Mixed causes were identified in 35% of patients, reflecting the clinical complexity of CES in older patients in terms of diagnosis and management (3,4,17,20). LV thrombus was observed in 4% of cases, and pacemakers in 9%. The most frequent stroke locations were the middle and anterior cerebral arteries (55%), followed by multifocal involvement (34%) a distribution typical of cardioembolic stroke (21,22). Cerebral infarcts of cardiac origin often present with multifocal involvement, reflecting embolic dispersion (4).

Therapeutic approaches and outcomes

Most of our patients received DOACs (85%), in accordance with current recommendations for non-valvular AFib (23–25). VKAs were used in 9% of cases. Thrombolysis was performed in 43% of patients, and MT in 4%. Rescue thrombectomy following failed thrombolysis was required in 9% of cases. Multiple studies, including a meta-analysis by Cao *et al*., have demonstrated that DOACs are associated with a significantly lower risk of major bleeding (RR = 0.70; 95% CI: 0.59–0.82) and intracranial hemorrhage (RR = 0.42; 95% CI : 0.26–0.70), while maintaining similar protection against stroke and systemic embolism (RR = 0.74; 95% CI: 0.50–1.08) (26). The use of VKAs may reflect specific clinical scenarios such as severe renal impairment, mechanical heart valves, or cost/access considerations. This proportion is consistent with real-world data, where VKAs remain necessary in selected subgroups. Our data show that nearly half of patients underwent thrombolysis, which is a robust rate, especially in elderly populations where eligibility is often limited by comorbidities or delayed presentation. Thrombolysis remains the cornerstone of acute ischemic stroke management and has been shown to improve functional outcomes when administered within the therapeutic window (27). The 4% rate of MT appears modest, but this may reflect the proportion of patients with large vessel occlusion or logistical limitations. Interestingly, rescue thrombectomy following failed thrombolysis was required in 9%, suggesting that MT was used selectively in cases of thrombolysis failure. This approach is supported by recent evidence indicating that successful recanalization via MT significantly improves outcomes, even in patients aged ≥85 years (28).

Mortality rate

This 3% mortality rate is also lower than that reported in other studies on CES in elderly patients, where rates typically range from 13% to over 30% depending on stroke severity and ICU admission status 2 (26-27,29). Such a low rate may reflect rapid and multidisciplinary care, high adherence to anticoagulation guidelines, reduced embolic complications, and a possible selection bias toward less severe cases or earlier presentation.

Study Limitations

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This study's limitations include its cross-sectional design, which hampers the ability to establish causal links between variables and cardioembolic stroke. Being a single-center study, the findings may not be generalizable to other populations. Additionally, the sample size of 100 patients limits statistical power, and reliance on retrospective data introduces potential biases. The lack of post-hospital follow-up further restricts the assessment of long-term outcomes. These aspects suggest the need for prospective multicenter studies with longitudinal follow-up to enhance our understanding.

Conclusion

CES remains a major clinical challenge in elderly populations. Our study highlights the predominance of AFib and DCM as leading causes. The high rate of DOAC prescription, tailored to individual patient profiles, reflects strong adherence to current anticoagulation guidelines and contributes to favorable outcomes. The use of thrombolysis and selective MT, including rescue strategies, underscores the importance of timely and multidisciplinary intervention. Further studies are needed to refine risk stratification and optimize therapeutic strategies in elderly patients with CES.

Author's contribution

TPK, JR-MK, NBB: conceptualization & coordination

AOP, TMT, FBH, KL: data collection, methodological review and statistical analysis

DMS, SB: provided echocardiographic expertise and participated in diagnostic interpretation

All authors reviewed and approved the final version of the manuscript.

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Disclosures

None

Competing Interest

The authors declare no competing interests.

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