Contemporary Management of Cardioembolic Stroke in Young Adults

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Abstract

Cardioembolic stroke is a clinically significant subtype of ischaemic stroke associated with increased severity, recurrence risk, and important implications for long-term secondary prevention. Although less common in young adults, it carries a disproportionate lifetime burden of disability and socioeconomic impact. In this population, stroke arises from a more heterogeneous aetiological profile, with a greater contribution from cardioembolic and non-atherosclerotic mechanisms, including occult atrial fibrillation, structural cardiac abnormalities, and patent foramen ovale. This narrative review demonstrates that accurate identification of the underlying embolic source is the central determinant of effective management in young adults. Clinical features alone are often insufficient to distinguish cardioembolic stroke from other subtypes, necessitating multimodal investigation, including neuroimaging, echocardiography, and prolonged cardiac rhythm monitoring. The key finding of this review is that secondary prevention is highly dependent on mechanism-based classification, particularly when distinguishing patients who may benefit from anticoagulation, antiplatelet therapy, or structural interventions such as patent foramen ovale closure. However, current management strategies are largely derived from older populations, limiting their applicability to younger cohorts. Overall, this review highlights a critical gap in age-specific evidence and underscores the need for personalised, source-directed management strategies. Future research should focus on improving risk stratification and developing targeted approaches to optimise long-term outcomes in young adults with cardioembolic stroke.

Introduction

Ischaemic stroke is classified into five aetiological subtypes according to the TOAST criteria: large artery atherosclerosis, small vessel occlusion, cardioembolism, stroke of other determined aetiology, and stroke of undetermined aetiology. Cardioembolic stroke represents a clinically important subtype due to its association with increased severity, recurrence risk, and implications for long-term management. (1)

Although age-standardised incidence rates of ischaemic stroke in young adults have declined in some global analyses, multiple population-based studies have shown an increased incidence in this age group, particularly over recent decades.

This rise has been attributed to a combination of growing prevalence of traditional modifiable vascular risk factors and age-specific mechanisms, including congenital structural cardiac abnormalities such as PFO. (1) The absolute number of ischaemic stroke-related deaths in younger adults has increased in particular, despite its lower overall mortality compared with older adults, attributed predominantly to population growth and demographic shifts. Young women, particularly those under 35 years of age, appear to be disproportionately affected. (2)

Ischaemic stroke in younger populations results from a more heterogeneous and less identifiable aetiological profile than those in older age cohorts.

Atrial Fibrillation (AF) -related cardioembolism and atherosclerotic disease are most common in older adults, whereas younger adults often present with intermediate-risk or occult (e.g. structural cardiac defects and embolic stroke of undetermined source) mechanisms. Traditional cardiovascular risk factors are less prevalent, leading to diagnostic uncertainty and potentially delays in targeted management. (1)

The aim of this narrative review is to examine the cardioembolic aetiology of ischaemic stroke in young adults, with emphasis on underlying mechanisms, diagnostic challenges, and implications for management and secondary prevention.

Methods

A narrative review of the literature was conducted in January 2026 to examine the epidemiology, aetiology, diagnostic evaluation, and management of cardioembolic ischaemic stroke in young adults. A literature search was performed using PubMed and Google Scholar. Search terms included combinations of "ischaemic stroke," "young adults," "cardioembolic stroke," "aetiology," "patent foramen ovale,""diagnosis," "management," and "secondary prevention." Boolean operators including AND and OR were used to combine terms and broaden retrieval. Relevant articles were selected based on relevance to cardioembolic stroke in young adults, with preference given to recent reviews, clinical studies, and guideline-based evidence. This review was conducted as a narrative review and was informed by the Scale for the Assessment of Narrative Review Articles (SANRA) to improve transparency and reporting quality.

The search primarily focused on articles published within the last ten years, with earlier landmark studies included where necessary to provide epidemiological context or support key management principles. Eligible articles were limited to English-language, peer-reviewed studies published up to December 1, 2025. Included study types comprised narrative reviews, systematic reviews and meta-analyses, population-based cohort studies, and case–control studies relevant to ischaemic or cardioembolic stroke. Studies focusing on young adults or early-onset ischaemic stroke were included, with age thresholds defined by individual studies, most commonly ranging from 18 to 55 years.

Given the limited availability of management and secondary prevention trials conducted exclusively in young adults, evidence informing treatment strategies was also drawn from broader adult stroke populations, with findings interpreted in the context of younger patients. Studies were excluded if they were case reports, paediatric-only, focused exclusively on rehabilitation or quality-of-life outcomes, or addressed non-ischaemic stroke. Relevant articles were selected based on their contribution to understanding age-specific differences in cardioembolic mechanisms, diagnostic approaches, and management strategies.

Aetiology

Cardioembolic stroke is a major cause of ischaemic events in younger populations and is characterized by mechanisms distinct from atherosclerotic disease, which accounts for a substantial proportion of arterial ischaemic stroke in older adults. (3) The most common sources of cardioembolic stroke include structural cardiac abnormalities, valvular disease and cardiac arrhythmias all of which predispose to thrombus formation.

Although primary vascular risk factors such as hypertension, smoking, diabetes mellitus may be present, evidence proves that young stroke patients more commonly exhibit age specific risk factors which includes pregnancy, oral contraceptive use, migraine, illicit drug use and congenital cardiac abnormalities such as PFO. (2) Among cardioembolic mechanisms, AF remains an important predictor of first and recurrent stroke, although it is less prevalent in younger populations. In contrast, PFO is particularly relevant in young adults with cryptogenic stroke and is reported in up to 45% of such cases, despite its high background prevalence in the general population. (2)

Diagnostic Approach Guiding Management

In young adults with suspected cardioembolic stroke, it is essential that an accurate diagnosis is established to guide management, as treatment strategies depend on identifying the underlying cause.

Neuroimaging plays an important role, with features such as bilateral infarcts and multiple territorial infarcts being more suggestive of an embolic origin, rather than lacunar infarcts, which are more likely to occur in patients without a cardioembolic source. (4) Magnetic resonance imaging (MRI), specifically diffusion-weighted imaging, is more accurate in identifying acute infarction and more sensitive for detecting involvement of greater than one-third of the middle cerebral artery territory compared with computed tomography (CT). (5)

A 12-lead electrocardiogram should also be performed in all patients to detect AF or other arrhythmias, along with inpatient telemetry. In adult patients with ischaemic stroke or TIA, longer duration cardiac rhythm monitoring (>48 hours), and where possible the use of an implantable loop recorder, increases the detection of subclinical AF. (6) Identification of atrial fibrillation is important, as oral anticoagulation significantly reduces the risk of recurrent ischaemic stroke compared with antiplatelet therapy.

Transthoracic echocardiography (TTE) is commonly used as an initial investigation to assess cardiac function, detect potential cardiac thrombi, and evaluate valvular abnormalities. Additionally, transoesophageal echocardiography (TEE) offers enhanced visualisation of certain cardiac structures and is able to identify embolic sources not visible on TTE, such as left atrial appendage thrombi and PFO. (7)

Overall, integrating neuroimaging, rhythm monitoring, and echocardiographic assessment is central to confirming a cardioembolic source and informing secondary prevention.

Management Strategies and Secondary Prevention

Acute management of cardioembolic stroke in young adults follows the standard ischaemic stroke pathway, including reperfusion therapies when indicated. As such, the long-term secondary prevention is fundamentally different based on embolic source, such that correct stroke aetiological classification is necessary. (8)

Current guidelines recommend anticoagulation, preferably with direct oral anticoagulants, for AF–related cardioembolic stroke, while antiplatelet therapy remains the standard for non-cardioembolic stroke.

Although AF is less common in young adults, failure to identify a cardioembolic source may result in suboptimal secondary prevention and increased recurrence risk. (9)

In young adults, PFO represents an important potential cardioembolic mechanism. (10) Initial medical management of PFO-associated stroke includes antiplatelet therapy, most commonly aspirin, or anticoagulation with vitamin K antagonists, alongside aggressive modification of vascular risk factors such as hypertension, smoking, and diabetes mellitus. (11) A systematic review and meta-analysis showed that PFO closure combined with antiplatelet therapy significantly reduced recurrent ischaemic stroke in patients younger than 60 years with cryptogenic stroke, although no clear stroke advantage was demonstrated when closure was compared with anticoagulation alone. (12)

In cases of recurrent stroke despite optimally managed medical therapy, percutaneous PFO closure should be considered, provided alternative stroke mechanisms have first been rigorously excluded through prolonged rhythm monitoring and detailed neurovascular imaging. (11) Overall, secondary prevention in young adults with cardioembolic stroke should be individualised according to embolic source, recurrence risk, bleeding risk, and the long-term implications of treatment.

Advances, Challenges and Future Directions

Recent developments in biomarkers, neuroimaging, and cardiac monitoring have improved identification of cardioembolic stroke, yet substantial diagnostic and therapeutic challenges remain, particularly in young adults. Distinguishing cardioembolic stroke from other causes of ischaemic stroke based on clinical features alone is difficult because of significant overlap between stroke subtypes. Adjunctive biomarkers such as B-type natriuretic peptide(BNP), D-dimer and Creatine Kinase-Myocardial Band(CK-MB) have shown potential to support identification of cardioembolic stroke, although current evidence remains limited. Patients with cardioembolic stroke have been reported to exhibit significantly elevated levels of these biomarkers, particularly when routine imaging and cardiac investigations are inconclusive. (13)

Despite advances in diagnostic techniques, establishing a precise cardioembolic mechanism remains difficult, as no single investigation serves as a definitive diagnostic gold standard. (14) Although enhanced neurovascular imaging and prolonged cardiac rhythm monitoring have improved detection of occult cardioembolic sources, diagnostic uncertainty persists in a substantial proportion of cases. In particular, rigid application of the TOAST classification system may lead to misclassification, with embolic strokes arising from non-stenosing large-artery atherosclerosis potentially being labelled as embolic stroke of undetermined source. This is especially relevant in young adults, in whom severe atherosclerotic stenosis is less common and embolic infarct patterns may predominate. (15)

A further limitation is the quality of the available evidence base. Much of the literature guiding management is extrapolated from older populations, despite younger adults having a more heterogeneous aetiological profile and different long-term treatment implications. Younger patients are often underrepresented in major trials of antithrombotic therapy and secondary prevention, which limits the generalisability of these findings to this age group. Consequently, management decisions in young adults frequently rely on observational studies, subgroup analyses, or extrapolation rather than robust age-specific evidence. Future research should therefore focus on age-specific risk stratification tools, stronger evidence for source-directed therapies in younger cohorts, and more personalised secondary prevention strategies.

Discussion

Approximately 15% of all ischaemic strokes occur in young adults and adolescents, however very limited research has specifically addressed this topic leading to a decrease in awareness. (16) There is a broad range of cases and a higher prevalence of cardioembolic strokes in younger patients. (17)

While the typical symptoms of a stroke is similar to that seen in older patients, the atypical symptoms can lead to delayed treatments. Symptoms including, dizziness, severe nausea and vomiting, cranial neuropathies etc. may slow down the diagnosing process as they are non-localising symptoms. (2)

Since stroke in the young adults has traditionally been considered unlikely, clinicians may prioritize exclusion of alternative diagnoses, resulting in delayed treatment. (16)

Non-motor outcomes are common six months post-stroke in young adults, with fatigue being the most frequent and impactful symptom, significantly affecting long-term function and quality of life. (18)

Conclusion

In conclusion, while ischaemic stroke is still less common in young adults compared to those in the elderly, the overall burden of stroke is growing, with increasing absolute stroke-related fatalities and long-term disability. The aetiological profiles of stroke in younger patients are more heterogeneous and less readily identifiable compared to older patient age groups. Such differences add to diagnostic uncertainty and delay targeted secondary prevention intervention implementation. While no single diagnostic test is established and existing classification systems will not necessarily capture the complexity regarding embolic mechanisms in young adults, progression in diagnostic approaches has refined diagnostic strategies and guided management decision-making. Further research is still necessary in improving this diagnostic precision and developing personalised secondary prevention approaches to reduce the lifelong burden of cardioembolic stroke in young adults.

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