



**EARLY DIAGNOSIS AND MODERN TREATMENT APPROACHES FOR ISCHEMIC
STROKE IN NEUROLOGY**

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Annotation

Ischemic stroke is a leading cause of mortality and long-term disability worldwide. Early diagnosis and timely management are essential to reduce infarct size, preserve neurological function, and improve patient outcomes. This review discusses advances in early detection using neuroimaging, thrombolytic therapy, endovascular interventions, neuroprotective strategies, and multidisciplinary rehabilitation. Evidence from recent clinical trials demonstrates that prompt treatment significantly enhances functional recovery and reduces complications. Secondary prevention measures, including antiplatelet therapy, anticoagulation, and lifestyle modification, are critical for reducing recurrence. Integration of rapid diagnostic techniques, evidence-based therapeutic approaches, and structured rehabilitation forms a comprehensive strategy for managing ischemic stroke. Continuous research and standardized clinical protocols are essential for improving prognosis and quality of life in affected patients.

Keywords

Ischemic Stroke, Early Diagnosis, Thrombolytic Therapy, Endovascular Treatment, Neuroprotective Strategies, Rehabilitation, Secondary Prevention, Functional Recovery.

Introduction

In modern neurology, Ischemic stroke is considered one of the most common and life-threatening acute cerebrovascular disorders, leading to high rates of mortality and long-term disability. This condition develops as a result of a sudden interruption of cerebral blood flow, which causes oxygen and glucose deprivation in brain tissue and leads to irreversible neuronal damage within a short period of time. Globally, ischemic stroke ranks among the leading causes of death and remains a major contributor to adult disability, significantly affecting quality of life and socioeconomic stability. The severity of clinical outcomes largely depends on the speed of diagnosis and the timely initiation of treatment. In neurology, the concept of the “therapeutic window” plays a crucial role, as early diagnostic and therapeutic interventions during the first hours after symptom onset can preserve viable brain tissue and reduce neurological deficits. Therefore, early diagnosis of ischemic stroke has become a priority direction in contemporary neurological research and clinical practice. Advances in neuroimaging techniques, the identification of laboratory biomarkers, and the development of thrombolytic and endovascular treatment strategies have significantly transformed stroke management. However, early-stage



clinical manifestations may be nonspecific, and differential diagnosis can be challenging in certain cases. These factors highlight the continuing relevance of improving early diagnostic accuracy and optimizing modern therapeutic approaches. In this regard, comprehensive analysis of early diagnostic methods and modern treatment strategies for ischemic stroke in neurology is of great scientific and practical importance. This article aims to explore these aspects and evaluate their clinical significance.

Relevance

Ischemic stroke is one of the leading causes of mortality and long-term disability worldwide. Early diagnosis and timely treatment are crucial for reducing brain damage and improving patient outcomes. Despite advances in neuroimaging and reperfusion therapies, delayed recognition and treatment remain major clinical challenges. Therefore, improving early diagnostic methods and modern treatment strategies is highly relevant in contemporary neurology.

Aim

The aim of this study is to evaluate early diagnostic approaches and modern treatment methods for ischemic stroke in order to improve clinical outcomes and reduce complications.

Main part

Ischemic stroke occurs due to blockage of cerebral arteries by thrombosis, embolism, or hemodynamic disturbances. The main etiological factors include atherosclerosis, arterial hypertension, cardiac arrhythmias particularly atrial fibrillation diabetes mellitus, and dyslipidemia. These factors cause pathological changes in the vascular wall, leading to thrombus formation or embolus detachment. Sudden cessation of cerebral blood flow results in oxygen and glucose deprivation in brain tissue. Energy production sharply decreases, and adenosine triphosphate synthesis is disrupted. Ion pump activity is impaired, causing intracellular accumulation of sodium and calcium ions. This leads to cytotoxic edema and neuronal injury. Excessive glutamate release triggers excitotoxicity. Oxidative stress increases, generating free radicals, while inflammatory mediators are released. A penumbra zone forms around the ischemic core, where cells are still viable but at risk. The primary goal of treatment is to preserve this region. Without reperfusion, neurons undergo necrosis. Understanding these pathophysiological mechanisms is essential for selecting appropriate therapeutic strategies and improving clinical outcomes.

Clinically, ischemic stroke manifests as sudden neurological deficits. The most common signs include unilateral hemiparesis or hemiplegia. Facial muscle asymmetry is often observed. Speech disturbances, such as aphasia or dysarthria, may occur. Visual impairment, including narrowing of visual fields, is sometimes present. Decreased consciousness indicates a severe course. Early detection relies on rapid screening tools such as the FAST test, which evaluates facial, arm, and speech functions. Neurological severity is assessed using the NIH Stroke Scale (NIHSS), helping quantify deficits and guide treatment. Determining symptom onset is critical, as therapeutic strategies depend on the “time window.” Differential diagnosis is essential to distinguish ischemic from hemorrhagic stroke and other neurological conditions. Prompt recognition allows initiation of reperfusion and supportive interventions. Public awareness of early warning signs is also crucial for reducing treatment delays and improving patient outcomes.



Neuroimaging plays a key role in ischemic stroke diagnosis. Computed tomography (CT) is typically the first-line imaging modality and effectively rules out hemorrhagic stroke. In early stages, CT changes may be subtle or absent. Magnetic resonance imaging (MRI), particularly diffusion-weighted imaging, has high sensitivity for early ischemia. Perfusion studies help assess the penumbra region, guiding therapeutic decisions. CT angiography evaluates vessel patency and is crucial for planning endovascular interventions. Laboratory investigations also provide important information. Complete blood count, glucose levels, coagulation profile, and lipid panel are routinely assessed. Prior to thrombolytic therapy, coagulation parameters are evaluated to minimize bleeding risk. Research on novel biomarkers is ongoing to enhance early detection. The combined use of imaging and laboratory tests significantly improves diagnostic accuracy, informs treatment planning, and optimizes clinical outcomes.

Thrombolytic therapy is a cornerstone in acute ischemic stroke management. Recombinant tissue plasminogen activator (rt-PA) is the most widely used agent. Administration within the first 4.5 hours after symptom onset significantly reduces neuronal damage. Early reperfusion restores blood flow to the penumbra zone and minimizes infarct size. Patient selection is crucial, considering age, comorbidities, and contraindications. Blood pressure, coagulation status, and recent surgeries are evaluated prior to therapy. rt-PA is delivered intravenously, with dosing based on body weight. Studies show that timely thrombolysis improves functional outcomes and reduces long-term disability. Risks include symptomatic intracranial hemorrhage, which requires careful monitoring. Combined therapy with antiplatelet agents is sometimes employed post-treatment. Protocols emphasize rapid transport to stroke centers and streamlined evaluation. Imaging confirmation of ischemia and exclusion of hemorrhage is mandatory. Continuous neurological monitoring during therapy ensures early detection of complications. Early rehabilitation initiation complements thrombolytic benefits. Clinical trials demonstrate higher recovery rates in patients treated within the therapeutic window. Guidelines recommend standardizing thrombolysis protocols across hospitals. Public education on recognizing stroke symptoms enhances timely intervention. Telemedicine has expanded access to thrombolysis in remote areas. Ongoing research focuses on optimizing dosing and extending the treatment window. The combination of thrombolysis with neuroprotective strategies is under investigation. Overall, thrombolytic therapy remains the most effective acute treatment for ischemic stroke when applied promptly.

Endovascular therapy is indicated for large vessel occlusions and selected patients. Mechanical thrombectomy uses stent retrievers or aspiration devices to remove occlusive clots. Early intervention within 6 hours of symptom onset significantly improves outcomes. Advanced imaging guides patient selection, identifying salvageable penumbra tissue. Combined therapy with intravenous thrombolysis may be performed in eligible patients. Angiographic evaluation confirms vessel patency post-procedure. Procedural complications include vessel perforation, dissection, or distal embolization. Post-intervention monitoring is essential to detect reperfusion injury or hemorrhagic transformation. Anesthesia choice depends on patient stability and procedural complexity. Multi-disciplinary stroke teams coordinate timely endovascular interventions. Studies show superior functional recovery compared to thrombolysis alone for large vessel strokes. Rapid access to comprehensive stroke centers is critical. Endovascular therapy extends the therapeutic window in selected cases up to 24 hours. Continuous research explores novel devices and techniques for higher recanalization rates. Patient outcomes depend on pre-procedure neurological status and collateral circulation. Antiplatelet therapy is initiated after confirming no hemorrhagic complications. Early mobilization complements procedural



success. Cost-effectiveness and resource allocation remain important considerations. Guidelines recommend standardized protocols for patient evaluation, procedural execution, and follow-up. Overall, endovascular therapy has transformed management of acute ischemic stroke with large vessel occlusions.

Neuroprotective therapy aims to preserve neurons in the ischemic penumbra. Pharmacological agents target excitotoxicity, oxidative stress, and inflammation. Calcium channel blockers and NMDA receptor antagonists reduce intracellular calcium overload. Free radical scavengers mitigate oxidative damage. Anti-inflammatory agents limit cytokine-mediated injury. Early administration enhances therapeutic efficacy. Combination with reperfusion therapies provides synergistic benefits. Clinical trials evaluate efficacy, safety, and optimal timing. Biomarker-guided therapy helps identify patients most likely to benefit. Animal studies provide mechanistic insights into neuroprotection. Drug delivery methods influence tissue penetration and therapeutic outcomes. Rehabilitation initiated during neuroprotective therapy enhances functional recovery. Adjunctive hypothermia reduces metabolic demand and limits infarct progression. Personalized medicine approaches are under investigation. Long-term outcomes include improved motor, cognitive, and language functions. Integration with thrombolytic or endovascular therapy is standard in comprehensive stroke centers. Continuous monitoring ensures detection of adverse effects. Public health strategies aim to increase awareness of early symptom recognition to facilitate timely therapy. Neuroprotective therapy remains a research priority for reducing stroke morbidity and mortality.

Rehabilitation is essential for restoring neurological function after ischemic stroke. Early mobilization reduces complications such as deep vein thrombosis and pneumonia. Physical therapy improves motor strength and coordination. Occupational therapy restores daily living skills. Speech therapy addresses aphasia and dysarthria. Cognitive rehabilitation enhances memory, attention, and executive function. Multidisciplinary teams coordinate individualized care plans. Assistive devices and adaptive technologies support functional independence. Nutritional assessment ensures adequate recovery. Psychological support addresses depression and anxiety common after stroke. Continuous monitoring detects secondary complications. Pain management and spasticity control optimize rehabilitation outcomes. Family education facilitates home-based care and adherence. Tele-rehabilitation expands access for remote patients. Standardized outcome measures track progress over time. Early rehabilitation initiation correlates with better long-term functional outcomes. Prevention of pressure ulcers and contractures is integral. Coordination with community services enhances social reintegration. Rehabilitation strategies are updated based on evidence-based guidelines and patient response.

Secondary prevention reduces risk of recurrent ischemic stroke. Antiplatelet therapy, such as aspirin or clopidogrel, is standard. Anticoagulation is indicated in atrial fibrillation or cardioembolic sources. Blood pressure control and management of hypertension are crucial. Lipid-lowering therapy, including statins, reduces atherosclerotic progression. Lifestyle modification includes smoking cessation, dietary adjustment, and physical activity. Diabetes management optimizes glycemic control. Regular follow-up and monitoring ensure therapy adherence. Carotid artery evaluation guides surgical intervention if needed. Patient education on recognizing early symptoms improves response time. Combination therapy may be applied for high-risk individuals. Rehabilitation programs support long-term functional maintenance. Risk factor modification reduces vascular events. Telemedicine facilitates ongoing monitoring and education. Community awareness campaigns enhance preventive measures. Personalized



prevention plans are developed according to patient risk profiles. Clinical guidelines inform pharmacological and non-pharmacological strategies. Multidisciplinary teams coordinate care to maximize effectiveness. Early intervention in minor strokes prevents major events. Overall, comprehensive prevention strategies significantly reduce stroke recurrence and improve patient outcomes.

Discussion and Results

Early diagnosis and timely intervention remain critical determinants of outcomes in ischemic stroke. The integration of modern neuroimaging techniques, including diffusion-weighted MRI and perfusion studies, has significantly improved the ability to detect ischemic lesions at a stage when neuronal tissue in the penumbra can still be salvaged. Thrombolytic therapy, when administered within the therapeutic window, consistently demonstrates reduced infarct size and better functional recovery. Endovascular treatment, particularly mechanical thrombectomy, further expands treatment options for patients with large vessel occlusions, showing superior outcomes compared to thrombolysis alone.

Neuroprotective strategies complement reperfusion therapies by mitigating excitotoxicity, oxidative stress, and inflammatory responses in ischemic tissue. Early rehabilitation, involving physical, occupational, and cognitive therapy, is essential for preventing complications and enhancing functional recovery. Despite these advances, challenges persist, including delayed hospital admission, limited access to specialized stroke centers, and variability in patient response. Addressing these barriers through public education, standardized protocols, and technological innovations such as telemedicine is crucial. Overall, a comprehensive, multidisciplinary approach that combines early detection, evidence-based medical and procedural treatments, and structured rehabilitation offers the best prognosis for ischemic stroke patients.

Analysis of current clinical data and studies indicates that early diagnosis and timely intervention significantly improve outcomes in ischemic stroke. Patients who received thrombolytic therapy within the first 4.5 hours demonstrated a marked reduction in infarct volume and improved functional independence compared to those treated later. Endovascular interventions for large vessel occlusions showed higher recanalization rates and better neurological recovery than thrombolysis alone. Advanced neuroimaging allowed accurate identification of ischemic core and penumbra, facilitating effective treatment planning. Neuroprotective therapies, when combined with reperfusion strategies, further minimized neuronal damage and enhanced recovery. Early initiation of multidisciplinary rehabilitation improved motor function, speech, and cognitive outcomes. Secondary prevention measures, including antiplatelet therapy, anticoagulation, and risk factor management, reduced the incidence of recurrent stroke. Overall, integrated approaches combining rapid diagnosis, modern therapeutic interventions, and rehabilitation resulted in lower morbidity and mortality, improved long-term neurological function, and better quality of life for patients. These findings underscore the critical importance of a comprehensive and time-sensitive strategy in the management of ischemic stroke.

Conclusion

Ischemic stroke remains a leading cause of mortality and long-term disability worldwide. Early recognition through clinical assessment and advanced neuroimaging is crucial for initiating



timely intervention. Modern treatment strategies, including thrombolytic therapy, endovascular procedures, and neuroprotective agents, significantly improve neurological outcomes when applied within the therapeutic window. Multidisciplinary rehabilitation enhances functional recovery, while secondary prevention strategies reduce recurrence and associated complications. The integration of rapid diagnosis, evidence-based therapies, and structured rehabilitation ensures optimal patient outcomes and improved quality of life. Continuous research, public education, and implementation of standardized clinical protocols are essential to further advance the management and prognosis of ischemic stroke.

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