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Innovative Approaches in Stroke Management for MicroRNAs and Nanocarrier Systems

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Description

One of the main causes of death and permanent disability in the globe is stroke. Strokes affect more than 15 million people worldwide each year and they continue to be a serious public health concern with significant socioeconomic repercussions. Stroke survivors frequently experience crippling side effects that can significantly lower their quality of life, such as emotional instability, motor dysfunction and cognitive impairments. Effective long-term recovery techniques are still scarce, despite improvements in the treatment of acute stroke. To enhance stroke care and patient outcomes, researchers have recently shifted their attention to cutting-edge treatment strategies such microRNAs (miRNAs), Post-Translational Modifications (PTMs) and nanocarrier systems [1]. This article examines these new approaches and how they can transform the way strokes are treated. Small non-coding RNA molecules known as microRNAs (miRNAs) are essential for post-transcriptional regulation of gene expression [2]. They have an impact on several biological processes, including as inflammation, oxidative stress, apoptosis, synaptic plasticity and Blood-Brain Barrier (BBB) maintenance. Since these mechanisms directly contribute to the pathophysiology of stroke, miRNAs are important therapeutic targets in stroke research. The ability of miRNAs to maintain the integrity of the Blood-Brain Barrier (BBB), a important structure that governs the movement of chemicals between the bloodstream and the brain, is among the most fascinating features of miRNAs in stroke [3]. The BBB is frequently weakened after a stroke, which causes inflammation and more brain damage. By focusing on particular transcription factors and angiogenic factors that regulate vascular integrity and endothelial cell activity, miRNAs can affect BBB function [4]. For instance, it has been demonstrated that miRNAs like miR-21 and miR-126 control angiogenesis and BBB permeability, indicating the possibility of using them as a therapeutic intervention in stroke rehabilitation [5].

Systems of nanocarriers

Since the BBB prevents many medications from entering the brain, getting therapeutic agents to the brain is one of the biggest hurdles in treating stroke. The efficacy of traditional therapies is restricted by this barrier as well as the intricate pathophysiology of stroke. Recent developments in nanotechnology, however, have created fresh method for addressing these obstacles. Particularly, lipid-based nanocarriers have drawn interest due to their potential to improve medication delivery across the blood-brain barrier. Therapeutic substances such synthetic medications, phytoconstituents, nucleic acids and peptides can be encapsulated by these nanocarriers, increasing their stability and bioavailability [6]. Nanocarriers can more effectively distribute these drugs by focusing on particular stroke-affected brain regions, which lowers the possibility of adverse effects and improves therapeutic efficacy. Controlled drug release is another benefit of using nanocarriers [7]. This is particularly important for stroke patients, as therapy efficacy depends on timing. For instance, in order to optimize their effects, medications that guard against oxidative stress, inflammation and excitotoxicity must be administered at particular points in the onset of a stroke. To guarantee that the medications are released at the ideal moment, nanocarriers can be designed to release their cargo in response to environmental cues like pH shifts or enzyme activity [8]. A number of nanocarrier systems, such as polymeric nanoparticles, solid lipid nanoparticles and liposomes, have been studied for the treatment of stroke. Preclinical research has indicated that these systems have potential in terms of better medication delivery, less neuroinflammation and improved brain function recovery. However, more investigation is required to improve their design, assess their safety and implement them in clinical settings, more study is necessary [9].

The future of stroke therapy

One area of stroke treatment that shows potential is the combination of miRNAs, PTMs and nanocarrier systems. PTMs shed light on the intricate regulatory processes behind stroke-induced brain damage, while miRNAs present a special chance to alter important biochemical pathways implicated in stroke pathogenesis. Conversely, nanocarrier systems provide a potent means of delivering therapeutic drugs across the blood-brain barrier and focusing on certain areas of the brain [10]. The creation of tailored, focused treatments for stroke patients is becoming more and more possible as research in these fields advances. Combining these innovative approaches may enable medical professionals to provide more potent therapies that enhance stroke survivors' quality of life and prevent stroke

recurrence while also encouraging long-term recovery. In summary, stroke is still a major worldwide health concern, but there is a lot of hope for better stroke care with the development of miRNA-based treatments, PTM-targeted medicines and nanocarrier drug delivery systems. The future of stroke treatment appears to be more potential than ever as we investigate these innovative strategies further.

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