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From Challenges to Solutions: Nanotech's Role in Epilepsy Care

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Key Points

Question:
Can nanotechnology-based treatments improve drug delivery and effectiveness in managing epilepsy, particularly for patients resistant to antiepileptic drugs (AEDs)?

Findings:
Nanoparticles enhance AED bioavailability and cross the blood-brain barrier (BBB) effectively. Nasal delivery is superior to oral routes, offering quicker brain access. Liposomes, dendrimers, and lipid nanocarriers reduce toxicity and improve biostability.
Nanoparticles amplify AED effectiveness by up to 30 times and support real-time drug monitoring. Potential use for transporting modified genetic material in epilepsy treatment.

Meaning:
Nanotechnology addresses drug resistance and BBB challenges in epilepsy, offering a promising alternative for more effective treatment, especially in refractory cases.

Abstract

Importance:
Epilepsy affects over 50 million people worldwide, making it a prevalent neurological condition characterized by an electrical imbalance in neurons. Despite treatment, antiepileptic drugs (AEDs) are ineffective for 30% of patients, largely due to limited bioavailability and the difficulty of crossing the blood-brain barrier(BBB). This challenge may be addressed through a novel approach involving nanotechnology-based medications, offering a promising solution for more effective epilepsy management.

Objective:
This paper presents an innovative approach using nanoparticles to cross the blood-brain barrier and examines the research question on the effectiveness of nanotechnology-based treatments for managing and controlling epilepsy.

Evidence Review:
This systematic review employed the PRISMA framework, gathering 552 studies from PubMed, Google Scholar, and ScienceDirect. After applying inclusion and exclusion criteria, 75 studies were selected for final evaluation. The review covers literature from the last five years, including systematic reviews, meta-analyses, and review articles. Key search terms included "Epilepsy," "Nanotechnology," "Seizures," "Drug delivery models," and "Effectiveness." Various types of nanoparticles were studied, including polymeric nanoparticles, liposomes, dendrimers, and nano-lipid carriers.

Findings:
This research paper reveals that nanoparticles encapsulating antiepileptic drugs (AEDs) offer enhanced bioavailability due to their efficient ability to cross the blood-brain barrier (BBB). Findings suggest that nasal administration is more effective than oral routes, as it bypasses the BBB and enables quicker access to the brain. Lipid-based materials like liposomes and dendrimers are uniquely structured to cross the BBB, are biodegradable, and therefore produce fewer toxic effects, improving biostability. Moreover, lipid nanocarriers, with properties such as anti-inflammatory and antioxidant effects, may reduce anxiety and protect brain cells from damage. Nanoparticles have the potential to amplify AED effectiveness by up to 30 times, allowing them to reach deep brain regions. These nanoparticles can also be utilized for transporting modified genetic material in epilepsy treatment. Additionally, they allow for real-time drug monitoring, control over release, and overall better pharmacological outcomes.

Conclusions and Relevance:
Given the challenges of drug resistance and poor targeting in current antiepileptic drugs (AEDs), nanotechnology offers an alternative solution to these issues. This approach enhances the treatment of status epilepticus, providing a more effective therapeutic option.

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