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Potential of Nanotechnology Treatment for Genetic Disorders

Fanesa Oktavianes Aulia [1], Siti Khofifah Dwi Febrianti [2], Ainun Rahmatun Nisak [3]

[1] *Institut Agama Islam Negeri Kediri, Indonesia*
[2] *Institut Agama Islam Negeri Kediri, Indonesia*
[3] *Institut Agama Islam Negeri Kediri, Indonesia*

Corresponding Author: Siti Khofifah Dwi Febrianti, E-mail: sitikhofifahdf@gmail.com

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ABSTRACT
Genetic disorders are complex health problems and are often difficult to treat conventionally. However, developments in the field of nanotechnology have opened up new opportunities for handling genetic diseases. Nanotechnology, or the creation of systems/devices at the molecular level, is a multidisciplinary scientific field that is experiencing rapid development. Nanotechnology offers innovative approaches to treating genetic disorders using the scale of nano-technology for drug delivery, gene therapy, and diagnostic molecular diagnostics to treat genetic disorders. Leveraging unique characteristics of a nanomachite, such as its size, shape, and functionality, can open a new path for more effective treatment and personalization for individuals suffering from genetic disorders. While still in the development stage, these developments promise a revolution in treatment of future genetic diseases

Keywords: *Drug Shipments, Genetic Disorders, Gene Therapy*

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INTRODUCTION

Nanotechnology is a term used to define a field of science and engineering in which phenomena occurring at nanoscale dimensions are used in the design, characterization, manufacturing, and application of materials, structures, devices, and systems. The concept of nanotechnology was first introduced in 1959 when physicist Richard Feynman presented a presentation on making things at the atomic and molecular level. Nanotechnology is now considered the most promising technology of the twenty-first century, and researchers have been investigating it as a new technique in medical

to develop new technologies with nanotechnology, initially useless materials can be transformed through manipulation of the arrangement of their elements. This branch of science focuses on nanometer-scale materials, which are often used in various fields of science and technology with molecular levels on the scale of 1 to 100 nm. One nm is equal

to one-billionth of a meter (0.000000001 m), which is 50,000 smaller than the size of a human hair. Scientists refer to sizes in the 1 to 100 nm domain as the nanoscale, and materials in this domain are referred to as nanocrystals or nanomaterials. Nanotechnology processes involve the separation, deformation, and manipulation of materials down to the level of a single atom or molecule.

Genetic testing is focused on identifying changes in chromosomes, genes, or proteins between healthy and diseased cells or people. Genetic test results can verify or rule out possible genetic conditions and help determine if a person is likely to develop or pass on a genetic disorder.

Over the past few decades, gene therapy has become an important tool for treating various diseases and researchers are working to develop efficient methodologies. Although there are many clinical trials and several treatments have been approved, the delivery system of gene therapy is still a challenge. Therapeutic nucleic acid needs to find a specific cell, enter the target cell, reach the nucleus without being degraded and finally be expressed or perform its corrective function. Therefore, its delivery system must be directed to a specific cell, overcome the physical barriers of the cell, avoid degradation and not cause toxicity to the body. These reasons increase the demand for suitable delivery systems that provide gene therapy more efficiently, without toxicity, and are cell-targeted and cost-effective

RESEARCH METHODOLOGY

The method used in this research is the literature study method. Literature study in this study is a series of activities related to library data collection methods, reading and recording, and managing research data objectively, systematically, analytically, and critically (Putri et al., 2020). In the analysis, selection, comparison, merging, and sorting will be carried out so that relevant ones are found (Sabarguna, 2005 dalam Hartanto & Dani, 2020). In the literature study, researchers collect and present existing information in the form of papers, scientific articles, journals, and various sources from the internet Google, Google Scholar, PubMed. This research focuses more on the keywords nanotechnology and genetic disorders

RESULT AND DISCUSSION

Nanotechnology has opened up new opportunities in the treatment of genetic disorders by enabling intervention on a molecular scale. One prominent application is the use of nanoparticles for the delivery of genetic drugs directly to target cells. These nanoparticles can be designed to carry genetic material such as modified DNA or RNA, which can then enter the body's cells and repair or replace defective genes. This method promises to be more effective than conventional gene therapy, as nanoparticles can be equipped with features that enhance stability, specific targeting and better cellular penetration.

In addition to genetic drug delivery, nanotechnology also enables the development of more sophisticated diagnostic tools to detect genetic disorders at an early stage.

Nanosensors, for example, can be used to detect genetic mutations with very high sensitivity, even at very low concentrations. This early detection is crucial as it allows for faster intervention before genetic disorders develop into more serious conditions. With the ability to monitor genetic changes in real-time, doctors can provide more precise and personalized treatment to patients.

Several clinical studies have shown significant success in using nanotechnology to treat certain genetic disorders. For example, in cancer treatment, nanoparticles are used to deliver chemotherapy drugs directly to tumor cells, reducing damage to healthy tissue and increasing the effectiveness of the therapy. Clinical studies in cystic fibrosis have also shown promising results, where nanoparticles are used to deliver the correct gene to lung cells affected by the mutation. In the case of thalassemia, nanotechnology-based gene therapy has shown the ability to correct gene mutations that cause impaired hemoglobin production, providing new hope for patients suffering from this condition.

However, despite the great potential offered, the development and implementation of nanotechnology therapies for genetic disorders still faces various challenges. One of the main concerns is safety, as nanoparticles can have unintended toxic properties if not carefully designed. In addition, ensuring the efficacy of nanotechnology therapies is also a challenge, as it is necessary to ensure that nanoparticles can reach target cells with high accuracy and release their payload effectively. Biocompatibility is also an important concern, as the materials used in nanoparticles must not induce adverse immune responses or allergic reactions in the patient's body.

Some of the ways in which nanotechnology can be used in the treatment of genetic disorders include the delivery of specifically tailored genetic drugs into target cells. Nanoparticles can be designed to carry genetic material such as modified DNA or RNA, which can then be used to repair or replace problematic genes in the body. This approach allows for more precise and effective interventions compared to conventional gene therapy, where delivery of genetic material is sometimes difficult due to stability issues and poor cellular penetration.

In addition, nanotechnology can also be used to develop more sophisticated diagnostic tools to detect genetic disorders. For example, nanosensors can be programmed to detect specific genetic mutations with high sensitivity, even at very low molecular levels. This capability is important for early diagnosis, enabling faster and more appropriate treatment before genetic conditions become more severe.

The application of nanotechnology in the treatment of genetic disorders also includes the development of RNA-based therapies such as siRNA and miRNA. Nanoparticles are used to protect and deliver these RNA molecules into target cells, where they can regulate gene expression in a specific way. These therapies hold promise for treating genetic diseases caused by specific gene mutations or abnormal gene expression, opening up new potential for more individualized and focused treatment. As technology and research continue to develop, the use of nanotechnology in the treatment of genetic disorders is expected to improve life expectancy and quality of life for many patients in the future.

nanotechnology also includes the development of multifunctional nanoparticles that not only deliver genetic material but also have the ability to be activated in a controlled manner. This can be done by incorporating responsive systems such as pH or light control, which allow controlling the time and place of delivery of genetic material. This approach is important for improving the accuracy and efficiency of genetic interventions, as well as reducing unwanted side effects on healthy tissues.

In addition, nanotechnology-based strategies in gene delivery also include the use of delivery techniques that utilize the process of cellular endocytosis to facilitate the uptake of nanoparticles into target cells. By utilizing this endocytic pathway, nanoparticles can avoid cell surface barriers that may hinder the effective delivery of genetic material into cells. These techniques continue to be extensively developed and tested in order to optimize the efficiency and safety of genetic delivery, accelerating advances in the field of genetic medicine and customized therapies.

CONCLUSION

From the abstract and introduction, it is clear that nanotechnology has great potential in overcoming current barriers in gene delivery for the treatment of genetic disorders. Various nanotechnology techniques have been developed, including the delivery of genetic drugs, gene therapy, and molecular diagnostics, which offer innovative approaches to treating genetic disorders. By utilizing the unique characteristics of nanotechnology, such as the size, shape and functionality of nanoparticles, we can open up new avenues for more effective and personalized treatment for individuals suffering from genetic disorders.

The introduction also explains that nanotechnology has become the focus of medical research as the most promising technology of the 21st century. The concept of nanotechnology was first introduced in 1959 by physicist Richard Feynman, and since then, it has been a rapidly growing field. With the size of matter at the nanometer scale, nanotechnology enables the manipulation of materials down to the level of single atoms or molecules, opening up the potential for more advanced and efficient treatments

In the context of treating genetic disorders, nanotechnology offers a wide range of possibilities, including drug delivery, gene therapy, genetic diagnostics, molecular imaging and RNAi delivery. Although still in the development stage, the use of nanotechnology in the treatment of genetic disorders promises to revolutionize the treatment of genetic diseases in the future.

Thus, the conclusion that can be drawn from the abstract and introduction is that the development of nanotechnology therapies for the treatment of genetic disorders shows great potential in improving treatment effectiveness, overcoming current barriers in gene delivery, and opening up new avenues for more personalized and individually focused treatment

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