NANOPARTICLE-BASED MEDICINES: ADVANTAGES AND SAFETY

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Abstract. Nanoparticle-based drugs are recognized as a revolutionary approach in modern medicine. The article examines the advantages of nanoparticle technology in drug development, their safety and clinical application. Nanoparticles allow for targeted drug delivery, increased efficacy, and reduced side effects. At the same time, issues regarding their toxicity and long-term safety are also analyzed.

Keywords : Nanoparticles, drugs, targeted delivery, safety, toxicity, nanomedicine, efficacy.

Аннотация. Лекарственные препараты на основе наночастиц признаны революционным подходом в современной медицине. В статье рассматриваются преимущества технологии наночастиц в разработке лекарственных препаратов, их безопасность и клиническое применение. Наночастицы позволяют обеспечить адресную доставку лекарств, повысить эффективность и снизить побочные эффекты. Также анализируются вопросы их токсичности и долгосрочной безопасности.

Ключевые слова: Наночастицы, лекарственные препараты, адресная доставка, безопасность, токсичность, наномедицина, эффективность.

Annotataiya. Nanozarrachalarga asoslangan dorilar zamonaviy tibbiyotda inqilobiy yondashuv sifatida tan olingan. Maqolada nanozarrachalar texnologiyasining dori vositalarini ishlab chiqarishdagi afzalliklari, ularning xavfsizligi va klinik qo'llanilishi ko'rib chiqiladi. Nanopartikullar dori-darmonlarni maqsadli etkazib berishga, samaradorlikni oshirishga va yon ta'sirini kamaytirishga imkon beradi. Shu bilan birga, ularning toksikligi va uzoq muddatli xavfsizligi bilan bog'liq masalalar ham tahlil qilinadi.

Kalit so‘zlar: Nanopartikullar, dorilar, maqsadli yetkazib berish, xavfsizlik, toksiklik, nanomeditsina, samaradorlik.

Introduction

Nanoparticles, i.e. particles with dimensions of 1–100 nm, have been used in medicine for many years. Their unique properties, such as small size, large surface area, and adaptability, make them a valuable tool for delivering drugs to specific sites in the body, increasing the effectiveness of treatment, and reducing side effects.

The small size of nanoparticles facilitates their interaction with body tissues and cells. For example, in traditional chemotherapy methods, drugs can spread

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throughout the body, causing damage to healthy cells. However, nanoparticles alleviate this problem by targeting the drugs only to diseased cells. As a result, the effectiveness of the treatment is increased, and side effects are significantly reduced [1].

Nanoparticles are currently being prepared from a variety of materials, such as liposomes, polymers, metal oxides, or organic materials, and each type of nanoparticle has its own unique advantages. For example, liposome-based nanoparticles are effective in delivering water-soluble drugs , while polymer nanoparticles are effective in providing sustained drug release. [2]

Literature review: Nanoscale drug research demonstrates their potential and benefits in medicine, but there are also serious questions about safety. Liposomal nanoparticles, such as doxil (liposomal doxorubicin), have been shown to be effective in treating cancer. These nanoparticles significantly reduce the adverse effects of chemotherapy on healthy tissue by specifically targeting drugs to tumors. Liposomes are made up of phospholipid bilayers, which entrap drug molecules and act stably within the body. Barenholz (2012) notes that liposomal nanoparticles are highly effective in delivering drugs to cancer cells. This technology is widely used, in particular, in the treatment of diseases such as breast cancer and Kaposi's sarcoma [3] .

Polymeric nanoparticles, which are biocompatible and stable, allow for the long-term and controlled release of drugs. They reduce the need to take medication regularly. Zhang et al. (2016) in their study emphasize the importance of polymeric nanoparticles in gene therapy and targeted drug delivery, and their adaptability expands the scope of their application against various diseases [4] .

Metal-based nanoparticles , mainly gold and silver, are of great interest due to their unique physicochemical properties. In diagnostics and treatment, gold is used in thermal therapy due to its interaction with light. It is effective in the treatment of infectious diseases due to its antibacterial properties.

Evaluating the safety and efficacy of nanomedicines: Statistical analysis is used to compare the benefits and safety of nanoparticle-based drugs. For example, meta-analysis combines efficacy or toxicity results from different studies to draw robust conclusions and reduce the limitations of individual studies. This method allows for systematic analysis of large amounts of data, for example, to assess the efficacy of liposomal nanoparticles in cancer treatment or the reduction of side effects.

The Cochrane criteria are used to assess the quality and reliability of studies . This methodology is one of the most prestigious in the world and examines the study design, data accuracy, experimental methods and the reliability of the results.

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For example, questions such as whether the methods were clearly described, whether the results were presented impartially, and whether the samples were large enough are considered. This process helps to include only high-quality studies in the analysis and to exclude those that are biased or biased.

Nanomedicines efficacy and application results: Nanoparticles have shown success in delivering drugs to specific target cells, especially in the treatment of diseases such as cancer. While conventional methods distribute drugs throughout the body and can damage healthy tissues, nanoparticles target only diseased cells and reduce side effects. Barenholz (2012) showed that liposomal nanoparticles, for example, when used internally, reduce side effects by 30–50%. This makes the treatment process more comfortable for patients, reducing nausea, fatigue, and immune suppression.

Nanoparticles enhance the bioavailability of drugs—the ability to be absorbed into the body and be active at the target site—by protecting them, ensuring their stability, and facilitating their delivery to the desired site. Zhang et al. (2016) found that this method increased the efficacy of treatment by 20–40%. Liposomal or polymeric nanoparticles protect drugs from enzymatic degradation and ensure that they remain active in the bloodstream for longer, which can improve the outcomes of cancer, cardiovascular, and infectious diseases.

Polymeric nanoparticles provide a controlled and gradual release of the drug, increasing the long-term effectiveness of the treatment process. Traditional dosage forms require frequent administration due to rapid degradation or excretion in the body.

Potential and safety issues of nanomedicines:

Nanoparticles deliver drugs to specific target areas, increasing the effectiveness of treatment and reducing the impact on healthy tissue. For example, liposomal nanoparticles (doxorubicin) reduce side effects in cancer treatment and improve the quality of life of patients. They keep the drug stable in the body, increase its bioavailability, and provide a long-term effect through gradual release.

However, safety issues are not fully resolved: nanoparticles can remain in the body for a long time and accumulate, leading to inflammation or chronic diseases. For example, carbon-based nanoparticles have been shown to be toxic to the lungs, while silver nanoparticles have been shown to be toxic to cells. Lipid-based liposomes are generally safer, but their long-term effects have not been well studied.

Nanoparticle-based drugs, including Doxil, are playing an important role in modern medicine, but standardized testing protocols and long-term studies are

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needed to ensure safety. In the future, safer materials and improved testing methods will allow the technology to be used more widely.

Conclusion: Nanoparticle-based drugs can be delivered precisely to diseased cells, reducing damage to healthy tissues and increasing the effectiveness of treatment. For example, liposomal drugs (Doxil) significantly reduce side effects in cancer treatment. Polymeric nanoparticles, on the other hand, release drugs slowly and have a long-term effect.

However, their safety has not yet been fully studied. Due to their small size, they can accumulate in the liver, kidneys, or lungs, causing inflammation and toxicity. Carbon and silver-based nanoparticles have been shown to have adverse effects, while lipid-based types are relatively safer, but their long-term effects are unknown.

Universal testing protocols, biocompatible materials, international standards, and long-term studies are needed to make the technology more widely available. These approaches will make nanoparticles safer and more effective in the future.

REFERENCES:

1. Barenholz, y. (2012). Doxil—the first fda-approved nano-drug: lessons learned. *Journal of controlled release* , 160(2), 117-134.

2. Zhang, l., gu , f. X., chan, j. M., Wang, A. Z., langer, r. S., & farokhzad, o. C. (2016). Nanoparticles in medicine: therapeutic applications and developments. *Clinical pharmacology & therapeutics* , 83(5), 761-769.

3. O berdörster, g., oberdörster, e., & oberdörster, j. (2005). Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. *Environmental health perspectives* , 113(7), 823-839.

4. Nel, A., Xia, T., Mädler, L., & Li, N. (2006). Toxic potential of materials at the nanolevel. *Science* , 311(5761), 622-627.

5. Desai N. Challenges in development of nanoparticle-based therapeutics // The AAPS journal. - 2012. - T. 14. – no. 2. - S. 282-295.

6. Huang Y. et al. Nanotechnology's frontier in combating infectious and inflammatory diseases: prevention and treatment //Signal Transduction and Targeted Therapy. - 2024. - T. 9. – no. 1. – S. 34.

7. Joseph TM et al. Nanoparticles: taking a unique position in medicine //Nanomaterials. - 2023. - T. 13. – no. 3. - S. 574.

8. Liu Y. et al. Advances in nanotechnology for enhancing the solubility and bioavailability of poorly soluble drugs // Drug design, development and therapy. - 2024. - S. 1469 -1495.

ISSN 3030-3907

9. Alshawwa SZ et al. Nanocarrier drug delivery systems: characterization, limitations, future perspectives and implementation of artificial intelligence //Pharmaceutics. - 2022. - T. 14. – no. 4. – S. 883.
10. Bezbaruah R. et al. Nanoparticle-based delivery systems for vaccines //Vaccines. - 2022. - T. 10. – no. 11. – S. 1946.
11. Thapa RK, Kim JO Nanomedicine-based commercial formulations: Current developments and future prospects //Journal of Pharmaceutical Investigation. - 2023. - T. 53. – no. 1. – S. 19-33.
12. Khalifa MMAH Safety of nanoparticles in medicine //Nanocarriers in neurodegenerative disorders. – CRC Press, 2024. – P. 94-10

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