EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 10
Issue: 8
44-47
Year: 2023

NOVEL DRUG DELIVERY OF BIOACTIVE ANTI CANCER DRUG: AN OVERVIEW

Ayush Chaurasia*, Shruti Khare and Ankit Singh

Advance Institute of Biotech & Paaramedical Science, Naramau, Kanpur, U. P.

***Corresponding Author: Ayush Chaurasia**
Advance Institute of Biotech & Paaramedical Science, Naramau, Kanpur, U. P.

Article Received on 29/5/2023 **Article Revised on 19/6/2023** **Article Accepted on 09/7/2023**

ABSTRACT
CurrentlyRight now, most cancer treatments involve removing the tumor through surgery. Chemical and physical treatments like chemotherapy and radiation therapy have also been effective in slowing down the growth of cancer cells. Sometimes, these treatments are combined to make them even more effective. However, these treatments can also harm normal cells and cause side effects that make life difficult for patients.Researchers are now exploring new ways to deliver chemotherapy drugs more effectively to improve the chances of a successful treatment. The field of cancer treatment is constantly evolving, and scientists are making exciting advancements in developing new strategies. Unlike traditional methods, these new approaches use targeted delivery systems that can specifically detect and attack cancer cells while minimizing damage to healthy cells. Some of these strategies include using specific molecules or receptors to target cancer cells, releasing drugs at the right time and place, delivering drugs directly into cancer cells, using gene therapy, targeting cancer stem cells, using magnetic fields to guide drugs to tumors, and using ultrasound to deliver drugs.These innovative approaches have shown promise in selectively detecting and destroying cancer cells with fewer side effects. Additionally, finding ways to overcome drug resistance and improving the transportation of drugs into cancer cells are also important aspects of these new treatment interventions.

KEYWORDS: Ligand or receptor based targeting, triggered release, intracellular drug targeting, gene delivery, cancer stem cell therapy, magnetic drug Targeting and Ultrasound-mediated drug delivery.

INTRODUCTION
Cancer is a very complicated and serious illness that is hard to diagnose and treat. The usual treatments for cancer, like chemotherapy, radiation therapy, and surgery, have some problems. They may not work well and can cause harmful side effects. But now, there are new ways to give cancer drugs to patients that could make treatment better. These new methods help deliver the drugs directly to the cancer cells, so they work better and cause fewer side effects. Scientists are developing these innovative ways to make cancer treatment more effective and safer. In this note, we will talk about these new ways of delivering drugs for cancer treatment and how they are improving the way we fight cancer [Lorscheider et al., 2021].

Targeted drug delivery
The targeted delivery of anticancer medications to cancer cells while preserving healthy cells is one of the main goals of innovative drug delivery systems. Several tactics, such as passive targeting, active targeting, and stimuli-responsive targeting, can be used to achieve this (Valery et al., 2022, Wang et al., 2018).

Passive targeting
In order to improve medication accumulation in tumour tissues, passive targeting takes advantage of the features of tumour microenvironments. Blood vessel leakage and poor lymphatic drainage are common in tumours, which causes the enhanced permeability and retention (EPR) effect. Utilising the EPR effect, drug delivery systems including liposomes, nanoparticles, and polymer conjugates can concentrate only in tumour tissues, increasing the effectiveness of drug delivery.

Active targeting
In order to specifically recognise and bind to cancer cells, active targeting entails the surface of drug carriers being coated with ligands or antibodies. These ligands can bind to cancer cell receptors that are overexpressed, making it easier for drug carriers to enter the target cells. Active targeting techniques increase medicine delivery Accuracy and Reduce side effects.

Stimuli-Responsive targeting
Stimuli-responsive drug-delivery systems are special tools that can be used to treat cancers in a more advanced way. These systems are designed to respond to different triggers in our bodies, like the environment outside the

body, the tumor tissue, the cells, or even smaller parts inside the cells. They have become very interesting because they can overcome various obstacles in our bodies and deliver different types of therapies to the right places. They are also useful for delivering multiple drugs and overcoming resistance to them.Stimuli-responsive drug-delivery systems work by using cues from the environment, such as changes in pH, temperature, enzymes, or magnetic fields, to release drugs at specific locations in the body. These systems are specifically designed to respond to the unique conditions found in tumor environments, ensuring that the drugs are released only where they are needed. Some examples of these systems include hydrogels, micelles, and nanogels. They have shown promise in the treatment of various diseases [Jia et al., 2021].

Nanotechnology-Based drug delivery

Through the development of new techniques and materials for the treatment of cancer, nanotechnology has completely changed the way drugs are delivered. Numerous benefits, such as greater drug stability, improved pharmacokinetics, and higher cellular absorption, are offered by nanoscale drug carriers. Following are a few significant nanotechnology-based drug delivery methods [Bertrand et al., 2014,Maeda et al., 2001].

Liposomes

Liposomes are small spherical structures made up of layers of fat. They can hold both water-loving and fat-loving drugs inside them. Liposomes are often used to deliver drugs because they are compatible with the body and can hold a wide variety of drugs. They are commonly used in cancer treatment. Liposomes are well-suited for carrying anti-cancer drugs because of their small size, special membrane properties, ability to hold a lot of drug, and compatibility with the body. They help to increase the solubility of the drugs and can release them slowly over time. PEGylated liposomes are used to prevent the drug from being quickly removed by the body's defense system, which allows the drug to stay in the body longer. This can increase the amount of time the drug is effective and reduce the number of times the patient needs to take it. These liposomes are used for treating solid tumors like breast cancer, as well as liquid tumors like multiple myeloma and leukemia. For drugs like Doxorubicin, being trapped in liposomes reduces side effects such as heart problems, vomiting, low white blood cell count, and hair loss, while still providing the same benefits as the regular drug. So, we can say that using liposomes improves the experience of taking Doxorubicin. Some well-known examples of liposomal anti-cancer drugs on the market are Liposomal Doxorubicin (Doxil) and Liposomal Daunorubicin (DaunoXome) [Lian et al., 2001].

Polymeric nanoparticles

Polymeric nanoparticles, such PLGA nanoparticles (poly(lactic-co-glycolic acid)), are adaptable drug carriers that provide regulated drug release, stability, and variable surface features. Both hydrophilic and hydrophobic medicines can be enclosed by these nanoparticles, which can also have their surfaces changed for targeted drug delivery.Nanoparticles (NP) are carriers that range in size from 10 to 1000 nm and contain anti-cancer medications in encapsulated or absorbed form. These nanoparticles can transport anti-cancer medications to their target tumours via passive or ligand-mediated mechanisms, despite several physiological obstacles. Because they are sensitive to pH, temperature, and other environmental factors, nanoparticles can be utilised to regulate the drug's release. This distribution not only assures that the formulation has a higher safety profile, but it also lessens the need for repeated dose administration. This makes it possible for people to take their prescribed dose at their convenience. Depending on the severity, these carriers are used to treat a variety of malignancies, including head and neck, breast, prostate, and other types.1 Paclitaxel, Nanosomal Docetaxel Lipid Suspension (NDLS), and D-tocopheryl polyethylene glycol succinate (TPGS)Docetaxel are a few examples of commercially accessible products. Healthcare technology is rapidly advancing nanocarriers [Gref et al., 1994].

Microspheres

Particles known as microspheres are created from biodegradable proteins or polymers. Through the use of release-controlling polymers, they are employed to entrap medications and manage their release. In order to provide long-acting medication release over an extended period of time, the polymer can regulate the release rate of the drug trapped in the microsphere core. The microspheres make the formulation extremely powerful in addition to ensuring improved drug absorption in the tumour. This improves therapeutic outcomes and lowers the possibility of medication toxicity. Additionally, they aid in reducing the signs of a high initial drug release, excessive flushing, and local side effects, which improves patient acceptance of the medication. In order to treat a range of tumours, including those caused by cancer of the prostate, ovary, lung, liver, large intestine, breast, bladder, and brain, microspheres are utilised. Leuprolide acetate (Lupron), Octreotide (Sandostatin), Mitoxantrone hydrochloride (Novantrone), and many others are examples of popular anti-cancer microsphere compositions [Hirota et al., 2016].

Dendrimers

Highly branching, resembling a tree, dendrimers have well-defined sizes and molecular weights. They provide exact control over the kinetics of drug loading and release. Dendrimers are excellent for targeted drug delivery and theranostics because they can be functionalized with targeting ligands and imaging agents. Novel nanoarchitectures called dendrimers have characteristics including a globular 3D shape, monodispersed unicellular nature, and a nanometric size range. Numerous peripheral functional groups are

available, and customizable surface engineering makes it simple to modify the dendrimer surface with various medicinal medicines, diagnostic agents, and targeting ligands. Dendrimers can be used therapeutically by drug encapsulation, solubilization, and passive targeting. We highlight recent developments in dendrimer-based anticancer drug delivery in this review, along with various biological and diagnostic applications. Together, dendrimers' enormous potential and utility are anticipated to have a profoundly favourable effect on the expanding field of medication delivery and targeting [Sharma et al., 2016].

Carbon nanotubes

Unique physicochemical characteristics of carbon nanotubes make them desirable medication delivery systems. They can move a range of medicinal substances, including as proteins, nucleic acids, and tiny molecules. Carbon nanotubes can be functionalized to enable imaging and targeted medication administration. Recently, carbon nanotubes (CNTs) have been proposed as a potential therapeutic drug delivery mechanism for both small and big compounds. It is possible to change the physical or biological properties of CNTs by functionalizing (i.e., surface engineering) them with specific functional groups. The enormous surface area of CNTs and the potential to control their surfaces and physical dimensions have been taken advantage of for usage in the photothermal death of cancer cells in addition to their capacity to act as carriers for a variety of therapeutic medicines [Abdelbary et al., 2012].

Emerging technologies

Several emerging technologies show promise in the field of novel drug delivery for cancer treatment:

Immunotherapy: Immunotherapy, which uses the body's immune system to combat cancer cells, has completely changed how cancer is treated. To improve the delivery and potency of immunotherapeutic drugs including immune checkpoint inhibitors, chimeric antigen receptor (CAR) T-cell therapy, and cancer vaccines, novel drug delivery systems are being developed. These systems seek to increase immune cell activation in the tumour microenvironment, extend medication circulation, and improve tumour targeting. Cancer immunotherapy has significantly improved patients' chances of surviving and quality of life as compared to earlier standards of care (such as chemotherapy, radiation, and surgery). From the metastatic stage to the adjuvant and neoadjuvant settings in several cancer types, immunotherapy has now firmly established itself as a novel pillar of cancer care. In this review article, we focus on how the evolution of cancer immunotherapy opened the path for advancements that have become the norm in medical practise. We also discuss the current drawbacks and restrictions of cancer checkpoint immunotherapy and how cutting-edge studies in the areas of personalised cancer vaccines, autoimmunity, the microbiome, the tumour microenvironment, and metabolomics are attempting to address those difficulties [Akkın et al., 2021].

Gene delivery: By delivering therapeutic genes to cancer cells to stop the growth of tumours or boost the immune system, gene therapy has a significant potential as a cancer treatment. To transfer therapeutic genes into cancer cells safely and effectively, new drug delivery techniques such viral vectors, nanoparticles, and liposomes are being investigated. These technologies can help with intracellular transport and expression while preventing genetic material degradation.3D printing technology makes it possible to create customised drug delivery systems with exact control over size, shape, and drug release kinetics. It enables the fabrication of microfluidic devices, scaffolds loaded with drugs, and implants tailored to individual patients. Drug delivery systems can be customised via 3D printing to meet the needs of each patient, enhancing treatment results and reducing side effects [Anas El-Aneed et al., 2004].

Microfluidics: Fluid manipulation in miniature systems can be precisely controlled via microfluidic platforms. With the use of these platforms, micro-scale drug delivery systems with high-throughput screening capabilities can be created. By simulating physiological settings, microfluidic devices can shed light on the toxicity, efficacy, and behaviour of drugs. They make it easier to study drug reactions in patient-specific models and to create personalised therapy [Zhang et al., 2013].

Challenges and Future directions:

While novel drug delivery systems hold great promise in cancer treatment, several challenges need to be addressed (Yarmush et al., 2014, Chen et al., 2013):

Scale-up and Manufacturing: Translating laboratory-scale formulations to large-scale manufacturing remains a significant challenge. It is crucial to develop scalable processes and ensure the reproducibility and quality control of drug delivery systems.

Biocompatibility and Safety: Novel drug delivery systems should undergo rigorous safety assessments to ensure their biocompatibility, stability, and long-term effects on the body. Preclinical and clinical studies are essential to evaluate the potential toxicity and immunogenicity of these systems.

Regulatory approval: Regulatory frameworks need to adapt to the rapid advancements in drug delivery technologies. Robust guidelines and evaluation processes are required to assess the safety and efficacy of novel drug delivery systems for clinical use.

Clinical translation: Successful clinical translation of novel drug delivery systems requires collaboration between researchers, clinicians, and industry partners. Well-designed clinical trials are necessary to

demonstrate the effectiveness and benefits of these systems in real-world patient populations [3-5].

CONCLUSION

In conclusion, novel drug delivery systems have the potential to revolutionize cancer treatment by improving drug targeting, bioavailability, and controlled release. These systems, including targeted drug delivery, nanotechnology-based platforms, and emerging technologies, offer promising strategies to enhance the efficacy of anticancer drugs while minimizing side effects. Overcoming challenges and continued research in this field will pave the way for more effective and personalized cancer therapies in the future.

REFERENCES

1. Lorscheider M, Gaudin A, Nakhle J, Veiman KL, Richard J, Chassaing C. Challenges and opportunities in the delivery of cancer therapeutics: update on recent progress. Ther. Deliv, 2021; 12(1): 55-76.
2. Valery V. Veselov, Alexander E. Nosyrev, László Jicsinszky, Renad N. Alyautdin, Giancarlo Cravotto. Targeted Delivery Methods for Anticancer Drugs. Cancers (Basel), 2022; 14(3): 622.
3. Wang Z., Deng X., Ding J., Zhou W., Zheng X., Tang G. Mechanisms of drug release in pH-sensitive micelles for tumour targeted drug delivery system: A review. Int. J. Pharm, 2018; 535: 253–260.
4. Jia R , Teng L , Gao L , Su T , Fu L, Qiu Z, Bi Y. Advances in Multiple Stimuli-Responsive Drug-Delivery Systems for Cancer Therapy. International Journal of Nanomedicine, 2021; 16: 1525–1551.
5. Bertrand N, Wu J, Xu X, Kamaly N, Farokhzad OC. Cancer nanotechnology: the impact of passive and active targeting in the era of modern cancer biology. Adv. Drug Deliv. Rev, 2014; 66: 2–25.
6. Maeda H. The enhanced permeability and retention (EPR) effect in tumor vasculature: the key role of tumor-selective macromolecular drug targeting. Adv. Enzyme Regul, 2001; 41(1): 189–207.
7. Lian T and Ho RJ. Trends and developments in liposome drug delivery systems. Journal of Pharmaceutical Sciences, 2001; 90(6): 667–680.
8. Gref R, Minamitake Y, Peracchia MT, Trubetskoy V, Torchilin V, Langer R. Biodegradable long-circulating polymeric nanospheres. Science, 1994; 263(5153): 1600–1603.
9. Hirota K, Doty AC, Ackermann R et al. Characterizing release mechanisms of leuprolide acetate-loaded PLGA microspheres for IVIVC development I: in vitro evaluation. J. Control. Rel, 2016; 244: 302–313.
10. Sharma AK, Gothwal A, Kesharwani P, Alsaab H, Iyer AK. Dendrimers nano-architectures for cancer diagnosis and anti-cancer drug delivery. Drug Discovery Today, 2016; 22: 314-26.
11. Abdelbary MA. Elhissi, Waqar Ahmed, Israr UlHassan,Vinod. R. Dhanak, Antony D'Emanuele. Carbon Nanotubes in Cancer Therapy and Drug Delivery. Journal of Drug Delivery, 2012; 1-11.
12. Akkın S, Varan G, Bilensoy E. A Review on Cancer Immunotherapy and Applications of Nanotechnology to Chemoimmunotherapy of Different Cancers. Molecules, 2021; 26(11): 3382.
13. Anas El-Aneed. An overview of current delivery systems in cancer gene therapy. J Control Release, 2004; 8, 94(1): 1-14.
14. Zhang JZ, Nagrath S. Microfluidics and Cancer: Are we there yet?Biomed Microdevices. 2013; 15(4): 595–609.
15. Yarmush ML, Golberg A, Sersa G, Kotnik T, Miklavcic D. Electroporation-based technologies for medicine: principles, applications, and challenges. Annual review of biomedical engineering, 2014; 16: 295–320.
16. Chen K, Huang YH, Chen JL. Understanding and targeting cancer stem cells: therapeutic implications and challenges. Acta pharmacologica Sinica, 2013; 34: 732–740.