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Mini Review: Nano-Technology based Drug Deliveries

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ABSTRACT

Targeted drug delivery with nano-technology has been researched and identified as being efficient across many treatment conditions. This review assesses some of the existing research work and evidence practice in using nano-technology based drug carriers.

Keywords: Nano-technology, drug delivery, nanoparticle formulation, nano-technology carriers, drug resistance

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Introduction

Targeted drug delivery or smart delivery is treatment methods that are used for the purpose of increasing medicine delivery and treatment efficacy[1-3]. Passive and active drug delivery methods are used with drug delivery vehicles that are even capable of crossing the blood-brain barrier[4-8]. This paper reviews the different Nano-technology based drug carrier or drug delivery systems that have been implemented and tested in contemporary practices. The pros and differentiated aspects of such delivery systems as compared to others are discussed.

Nano-technology forms of drug delivery

Nano-technology based forms of drug delivery are one of the most popular methods of drug delivery. Nanoparticles are smaller in size and this allows for better delivery of drugs that do not dissolve in water and thus can complete the first pass through liver metabolism[9-13]. Since nanotechnology forms of drug delivery ensure that the drug is circulated in the body for a longer time, it means that the drug is functional for more time. Plasma levels are therefore less-fluctuating and more stable. Nano-technology form of methods is useful against drug resistance effects. Nano-delivery methods can even cross the blood-brain barrier with least cytotoxicity[14-17]. These drug delivery methods are further extended as observed in the case of Yang et al.'s research work where gene delivery to cancer cells is facilitated. The delivery of nanoparticles through the blood-brain barriers as presented in Kang et al.,[10] research is presented below.

Yung et al., research focused on the efficient delivery of the AM-21 also called the microRNA-21 which is used in human cancer treatment. The authors propose the use of lipid nanoparticle formulations called the QTsome[18-23]. Nano-technology form of drug delivery was considered more effective in this situation. AM-21 is an effective therapeutic agent, but then after its release into the bloodstream, AM 21 is also cleared in a very fast manner from the bloodstream. Additionally, the medicine is not capable of penetrating the cellular membrane and hence does not deliver medicine to targeted sites efficiently. In the past, a chemical modification of the lipid nanoparticle backbone has been considered necessary[24-27]. The use of Nano-carriers in such situations showed enhanced therapeutic effects and reduced the cytotoxicity in normal cells. Off-target cytotoxicity was reduced to a great extent because of active targeting. Use of combination and Nano delivery methods reduces tumor growth more than others as highlighted below.

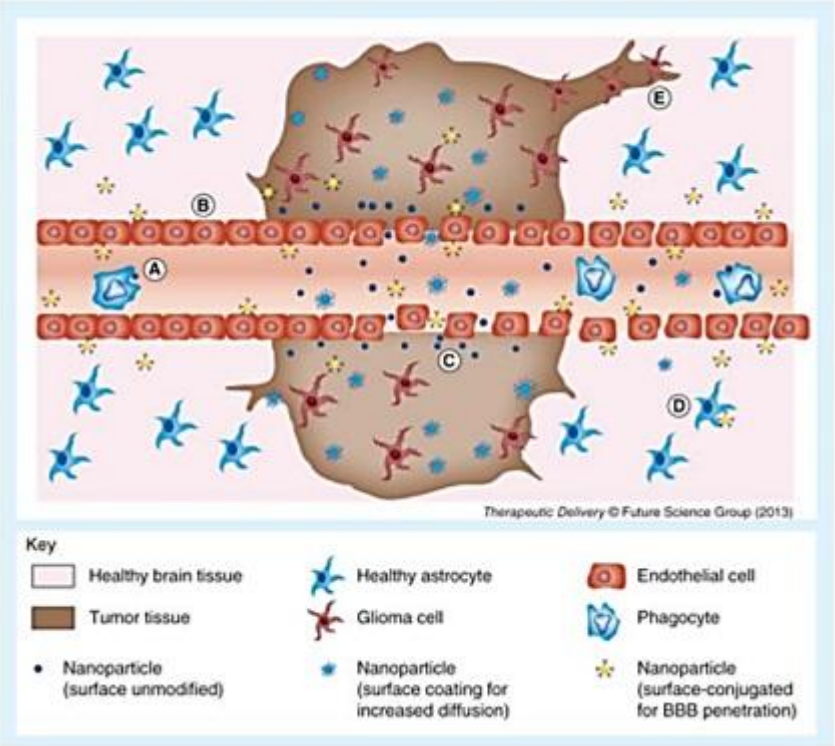

Figure 1: Nanoparticles and the BBB, (Kang et al.,)

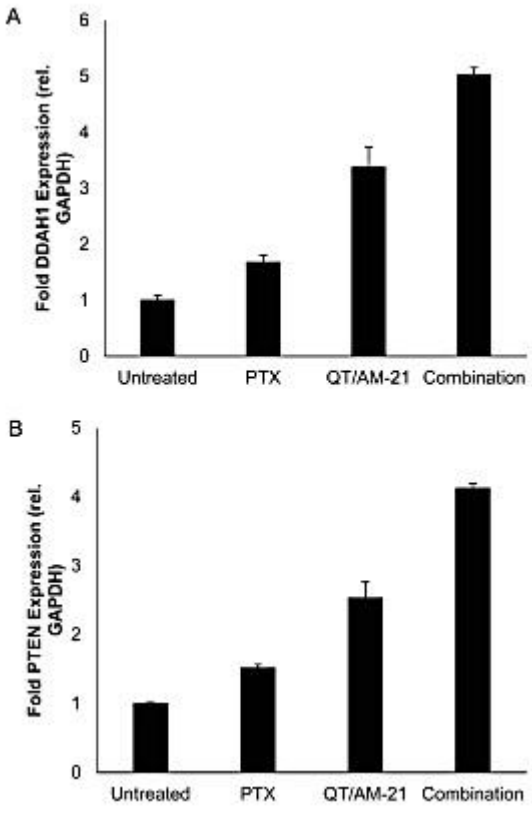

Figure 2: In-vivo results (Yung et al.,)

The use of the QTsome as a novel nanoparticle formulation ensures that a more responsive profile is developed for medicine delivery[28-30]. Nanoparticle-based platforms for delivery are an enhanced system on account of its low molecular weight. The small size and high drug loading capacity of QTsome nanoparticle lend to better long-term stability.

Targeted delivery

Targeted delivery helps deliver the needed medicines to the sites of action. Camptothecin acts as a DNA topoisomerase 1 inhibitor. It is used as an anti-tumor agent. Replication of cancer DNA is terminated with the Camptothecin. Although exhibiting cytotoxicity against tumor cells, the E-lactone ring in the drug Camptothecin is unstable. As a result of its instability, inactive carboxylates are formed. Moreover, the drug has poor aqueous solubility[31-34]. Issues in biodistribution exist as well. In this context, targeted delivery systems such as the nano-technology systems by property of selective deliverance will send the drugs directly into the tumor cell, instead of distributing it across normal tissues. Permeability and retention effects cause the delivery of nanoparticles across blood vessels as well. Compared to the traditional delivery modes, the medicine is retained for a much longer time.

The work of Kang et al. on the delivery of nanoparticles in the case of brain tumor highlights how chemotherapy results in drug resistance issues and issues of cytotoxicity in off-target regions for brain tumors like the glioblastoma. Brain tumors cannot be detected at an early stage, and when detected, the usual course of treatment is surgery followed by chemotherapy or radiation. Chemotherapeutic drugs usually end up causing high levels of off-target cytotoxicity, and over time, patients could end up becoming resistance to some chemotherapeutic drugs as well. This drug resistance questions the efficacy of the treatment program for the patient. The efficacy of treatment becomes questionable. The chemotherapeutic drugs fail to cross through the blood-brain barrier (BBB) and the insufficient concentrations will not be enough to restrict the progressive growth of tumors in tumor sites even after debulking surgeries[35-39]. In this context, the

nanotechnology form of drug delivery crosses the barrier and delivers medicine at the tumor site. It is used in antipsychotic drug delivery. Psychosis is a severe mental health problem involving delusions, catatonia and more. Antipsychotics that are used for their treatment have many side effects. Sun et al. argue for the use of nanoparticles in antipsychotics administration. Brain targeting drugs help create slow release profiles of drugs that are far more aqueous soluble and efficient than other delivery forms.

Nanotechnology can be used for the early detection of the tumor in some situations and its value is extended beyond just a carrier as observed in current research works. For example, consider the research work of Yang et al. where nanotechnology is applied to use nanoscaled exosome mimics NM. Exosomes are the smallest of the extracellular vehicles and contain genetic information for intercellular communication. The rapid abnormal proliferation of cells as in the case of cancer can be handled by communication of genetic and proteomic information through the nano-technology applied exosome mimics. Both in-vitro and in-vivo analysis holds many benefits[10].

Conclusion

Targeted delivery methods ensure that drugs are delivered to the required site of action in an efficient manner. The work reviewed the Nano-technology drug delivery systems such as AM-21, Camptothecin, chemotherapeutic drugs for the brain tumor and antipsychotic drugs for psychosis. The targeted delivery does not only increase efficacy but also causes reduced harmful actions in target off-site.

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