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REVIEW ARTICLE

Nanotherapy for Cancer – A Review

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ABSTRACT:
Nanomedicine is a field of medicine with the application of nanomaterials, nano biosensor and other nano level biological materials. At present, Nanotherapy has rapid growth in the field of nanomedicine for the treatment of various diseases. Nanotherapy involves the usage of nanoparticles to deliver a drug to its target. The nanoparticles employed here acts as a carrier for drugs. Nanotherapy is mainly directed towards the cancer treatment. Since the drug attacks both healthy and cancerous cells. To avoid the drug targeting the healthy cells the nanoparticles acts as a carrier and aids the drug in targeting the cancer cells specifically. Thus Nanotherapy is preferred than chemotherapy in the treatment of cancer as it overcomes few drawbacks in it. It also involves nano drug molecules in targeting cancerous cells. There are many methods in the delivery of nanoparticles. The nanoparticles are chosen based on their size, reactivity etc. This review covers up the advantages and challenges of nanotherapy for cancer treatment.

KEYWORDS: Nanotherapy, nanoparticles, nanomedicine, anti-cancer, drug delivery.

INTRODUCTION:
Cancer is a malignant disease which has higher prevalence rate over the world. Research has being carried out to eradicate and treat the cancer. Since the prevalence rate is increasing the possible therapies, preventive measures have to be followed by the subjects. Cancer is treated by the combination of chemotherapy, radiation therapy and some of the targeted therapies. Apart from other branches of science Nanotechnology has vital role in the treatment and diagnosis of cancer Nanotechnology is an evolving technology in the field of science and biological research and it is a promising technology with numerous applications in curing diseases[1]. Nanomedicine applies the tools of Nanotechnology in prevention and treatment of diseases. In the field of Nanomedicine clinical research on cancer, drug delivery systems, in vivo imaging, nanodevices are being done.

Nanoparticles of metals and other materials are being employed in many research experiments, clinical activities, drug delivery, etc. Research works have stated that nanoparticles have antimicrobial activity especially against bacteria [2,3]. Nanoparticles can be synthesised from microbial sources, organic and inorganic matter, plant and animal sources etc [4-6]. These particles play a crucial role in drug delivery for treating diseases. There are many types of nanoparticles being used with therapeutic applications [7]. Various methods have been followed in drug delivery with nanoparticles (*in vivo*) like using devices, encapsulation method and other effective systems [8-11]. As of now Nanotherapy is mostly preferred than other conventional methods for the treatment of cancer. For example, in Chemotherapy it has a risk of side effects like hair loss, nausea, vomiting, diarrhoea, anaemia, infections, fatigue, loss of taste buds, and destruction of the immune system which may also reduce the survival rate of the affected individuals. As the drug may invades the healthy cells along with the cancerous cells (target). The Nanoparticles acts a carrier for the drug and takes it to its respective target without killing other cells. Apart from drug delivery, nanoparticles are being used in diagnosis of cancer [12,13].

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NANOPARTICLES IN CANCER TREATMENT:

1. Magnetic Nano Particles (MNPs):

Magnetic nanoparticles have been used in therapy for cancer and in diagnosis. Their size is compared to the DNA or sub-cellular organelles. Their applications are Magnetic drug targeting, Cell separation, Magnetic Resonance Imaging (MRI), Hyperthermia. The standard MNPs are Iron, Nickel, Cobalt, Magnetite (Fe_3O_4), Hematite (Fe_2O_3) [14].

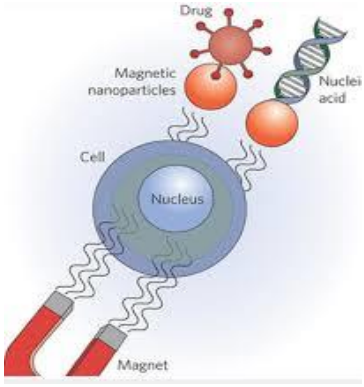

Fig 1. Representation of magnetic particles in drug delivery [15].

2. Gold Nano Particles (GNPs):

Gold nanoparticles are used as drug carriers, in thermal therapy, as contrast agents, *in vivo* and *in vitro* studies, as radiosensitizers, etc. Gold nanoparticles exist in non-oxidative state and are preferably small so it can easily penetrate into the body [16].These particles are actively employed most in treating the pancreatic cancer [17].

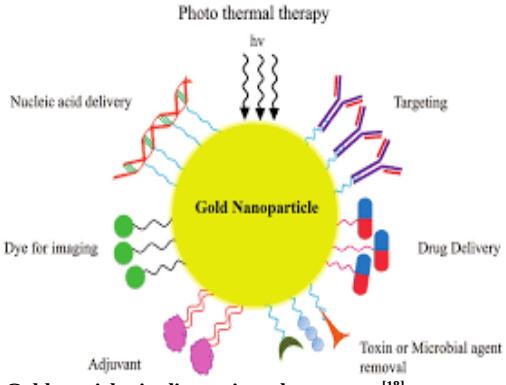

Fig 2. Gold particles in diagnosis and treatment[18].

3. Polymeric Nanoparticles:

Polymers at nano level derived from various sources have been assigned in cancer therapy either as drug carrier or as an anti-cancer agent. For example, nanocurcumin from rhizome of turmeric has anti-cancer property [19]. In contrast, the polymeric nanoparticles can also be conjugated with the drug and be used as a drug carrier in drug delivery systems [20].

4. Nanocarriers based drugs:

Anticancer activity based drug have been developed with nanocarriers. The nanocarrier molecules are attached with ligands that are specific to the target. The salient features of nanocarriers are enhancing the absorption of drugs in to the selective tissues, improves intracellular penetration, made up of biocompatible materials. Examples – Polymer-protein conjugate, liposomes, radio-immuno conjugates, PEG-liposomes [21].

APPLICATIONS OF NANOTHERAPY:

The main application of Nanotherapy is the treatment of cancer. Various types of cancer are treated or diagnosed by implementing Nanotherapy. The following are the applications of Nanotherapy:

- Prostate is a small gland that produces seminal fluid in Men. The cancer cells grow slowly and are confined to the prostate gland. Prostate gland cancer is easily detectable. Gold nanoparticles are employed in controlling the growth of the prostate cancer cells. These nanoparticles cause localised heating upon the targeted cancer cells and results in cell damage [22].
- Cancer Stem Cells (CSCs) are tumorigenic and are capable of differentiation. In recent, articles shows that breast cancer stem cells have been targeted by Graphene Oxide (GO) nanoparticles by differentiation based nanotherapy [23].
- Drug delivery nanocarriers for brain cancer have potential outcomes in treating and diagnosis. Special novel nanoparticles have been designed targeting the brain cancer cells [24].
- The prevalence of ovarian cancer became more common among women and often remains undetectable. ROS (Reactive Oxygen Species) induced nanotherapeutic approaches have resulted in treating ovarian cancer [25].
- PEGylated drug-carrying liposomes have been developed in treating the stromal response produced by Pancreatic Ductal Adenocarcinoma (PDAC) which may elicit other problems too. Since the drug fails to target the PDAC response, a carrier is employed to target the cells [26].
- Zirconium Phosphate Nanoplatelets (ZrP) are the anticancer drug carriers for breast cancer treatment. ZrP is encapsulated with the drug and introduced to attack the cancer cells. ZrP with Cisplatin can be used in treatment of ovary, breast, neck, bladder cancer treatment [27].

ADVANTAGES OF NANOTHERAPY:

Nanotherapy overcomes the disadvantages resulted from chemotherapy and radiotherapy [28]. Nanoparticles are smaller and they have larger surface area which makes

them to act as a suitable drug carrier. Nano scale particles them itself have the ability to interact with the cells and destroys them. As the drug which has high reactivity may kills the normal cells also, so to avoid this nanocarriers are encapsulated with drugs. This enables the drug particles to target only the cancerous cells. Nanoparticles themselves can acts as an anticancer agent. Some nanoparticles involve thermal reactions in destroying it. They are the suitable carrier system for drugs [29].

CHALLENGES ON NANOTHERAPY:

The Nanotherapy procedures involves significant method which are expensive than the common therapies. However in malignant cases nanotherapy is followed to cure the diseases. Another drawback of nanotherapy is the difficulties of extraction of nanoparticles. The synthesis of nanoparticles is also a tedious process. Some nanoparticles may also affect the immune system of the body during recovery period. Cross reactions may occur between the particles and the immune cells. In a study, engineered nanoparticles are said to cause the damage of cellular DNA [30]. Evaluation and screening of Nanoparticles through in vitro assays also has some limitations [31]. Prolonged exposure of nanoparticles may cause toxic effects and leads to the destruction of normal cells [32]. In some cases, nanoparticles have low drug delivery efficiencies [33].

NANO DRUG DELIVERY SYSTEMS:

NANOTUBES:

Nanotubes are suitable nanomaterials with good conductivity and mechanical strength in drug delivery systems. Nanotubes comfort the delivery of high dosage of drugs with minimal effects on normal cells or organs [34]. Carbon nanotubes have unique properties and are appropriate for nanotherapy. They have been used in both detection and delivery systems [35].

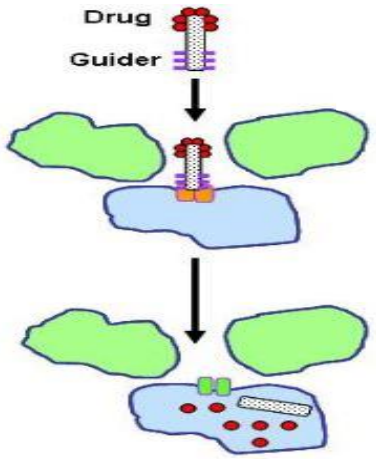

Fig. Targeted dug delivery using nanotube [36].

NANOSPHERES:

Nanospheres are spherical particles similar to nanoparticles which is encapsulated or entrapped with active compounds for therapeutic applications. Poly (lactic-co-glycolic acid) (PLGA), poly (lactic acid) (PLA), and poly-caprolactone (PCL) are some of the synthetic polymers used for the production of nanospheres [37]. Due to their biocompatibility nature nanospheres are used as a media for drug delivery in curing cancer. Methods like solvent displacement, spray drying, phase separation, self assembly, emulsion solvent eveporation are followed in loading a drug to the nanosphere [38].

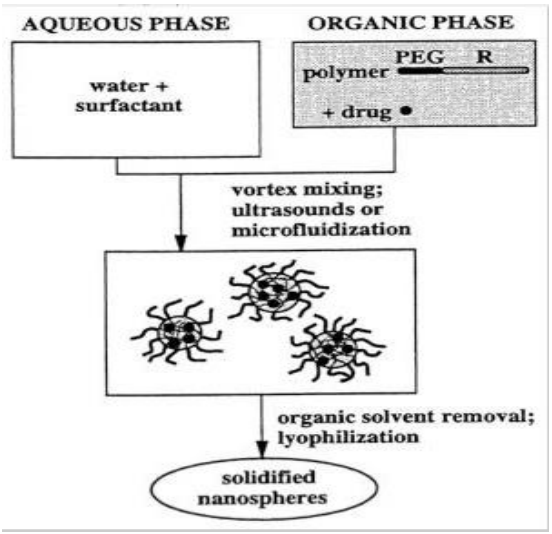

Fig. Schematic representation of drug loading in to the nanosphere by emulsion- evaporation procedure [39].

NANOCAPSULES:

Nanocapsules are nano level shell like substances made up of polymers. Nanocapsules are efficient vehicles for drug delivery as the drug can undenibly be loaded to the cavity of the capsule through nanoprecipitation, emulsion-diffusion, double emulsification etc [40]. In cancer therapy, magnetic nanocapules are prepared by coating them with silica to make them porous to take up the anti-cancer drugs [41].

NANOBOTS:

Nanobots are machines or robots at nano scale are employed in transporting drugs into the targeted tissues, cell imaging, probing etc. Robots constructed from DNAzymes are resourcefully carries the small doses of drug particles to conquer over the drawbacks of the conventional methods [42]. Nanobots take up the drugs and are introduced directly in to the tumours through machine gun approach. It creates a shielding layer from the normal cells whereas the tumour cells are destroyed by the drug released from the nanobots [43].

NANOFLUIDS:

Nanofluids are engineered colloidal fluids with nanoparticles. The nanofluids bearing the nanoparticles with anti-cancer drugs will recognise the cancer cells and are targeted with the drug molecules [44]. Peristalitic flow of the magnetic nanoparticles in the nanofluid promotes the interaction of the drug and targeted cells [45, 46].

MICELLAR NANOPARTICLES FOR DRUG DELIVERY:

In recent, Micelle is an aggregate used for drug delivery in healing cancer and other disorders. Such kind of micelles has been developed with compatibility and effective delivery system [47]. Fabrication is done with the polymers to make the micelle a successful drug delivery system [48, 49]. Among other delivery systems micelles have improving releasing capacity [50].

CONCLUSION:

Thus various forms of nano drug delivery systems have been employed for an effective delivery of anti cancer drugs. The emerging concepts of Nanotechnology have proven to be successful in the treatment of cancer. Apart from few drawbacks nanotherapy always is a successful treatment and even a diagnostic tool for cancer. It provides a way for further more curing therapies for cancer and other dreadful diseases. Nanotechnology paved a way for carrying out research for the obliteration of cancer.

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CONFLICTS OF INTERESTS:

The authors declare that they do not have any Conflicts of Interests.

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