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Review Article

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NANOTHERANOSTICS: A REVIEW

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ABSTRACT

Nanotheranostics is a novel drug delivery system, advanced than or superior than nanoparticle drug delivery system. It represents the highest level of technology in nanomedicine field. It also possesses diagnostics and therapeutic function for attractive personalized medicine. Nanotheranotics act as a dynamic frontiers for pathological remedies and Nanotheranostics working mechanism is based on physical, chemical and biological triggers which helps for activation of diagnostics as well as therapeutics function. Nanotheranostics have the ability to broaden nanoparticles like gold nanoparticles, silver nanoparticles, magnetic nanoparticles, polymer nanoparticles, etc. In this review, we explore some technologies which are helpful in the

development of theranostics. These are more robust and superior technologies than the conventional nanoparticle system. Those different forms of novel nanoparticles investigated for the multifunctional purpose, such as diagnosis, cancer treatment, personalized medication, etc., high rank biocompatibility, good storage stability, targeted drug release and protect drug degradation from the internal body environment. Those robust nanoparticles also have ability to be used in the treatment of various cancers, tumors with beneficial immunological responses.

KEYWORDS: Nanotheranostics, Nanotechnology, novel nanoparticles, nanomedicines.

INTRODUCTION

Nanotheranostics is a novel multifunctional drug delivery gadget which is superior than the nanoparticle drug delivery gadget. It is the maximum degree of technology superior in nanomedicine field. Nanotheranostics is a combination of "nanoparticles" and "theranostics". These theranostics having reducing edged field of drugs that are having the movement in an

aggregate form, which indicates analysis as well as remedy simultaneously. It is a superior device of theranostics, which contain the "nanotechnology" for analysis cause as well as remedy ailment.^[1] Nanotheranostics are used for monitoring of different remedies and help to reduce the potential of dose. It is helpful in the diagnosis of most of the cancers and also determines the molecular exchange in sickness.^[2] These theranostics medicinal drugs have capability to enter the systemic circulation and also has a potential to break the host defense mechanism. These release the drug or analytical agents at the center website, online with much less degradation of drug molecule and treat precise sickness at molecular as well as cell level. The diagnostic and healing retailers are determined in the mixture in Nanotheranostics which binds to the organic ligands, all through targeting process and achieve a proper goal without destroying of drug molecules. Also, theranostics advocate the response in opposition to oral delivery, multimodality cures, synergistic and combinatorial cures and stimuli responses in addition to personal therapies. It is least life threatening medicinal drug.^[3] The design of Nanotheranostics additionally, has the ability to provide data about drug biodistribution, their launch and the focused of the treatment. The development of Nanotheranostics determines the dynamic frontiers in the treatment of pathological remedy. Working mechanism of theranostics is totally based on physical, chemical and biological triggers which get activated at the best centered site. These Nanotheranostics are very sensitive to pathological stimuli like alteration of pH, oxidative stress, enzymatic pressure and lively biological molecule.^[4] This is a very powerful agent which deals with the most cancers in a powerful manner and having better focused remedy. Theranostics having a precise goal in the direction of the treatment which develops unique and individual healing strategies in the direction of the character treatment or personalized remedy and optimize remedial strategies and monitor treatment effect.^[5] These theranostics have particular intrinsic houses which suggests the unique functionalization software and imaging houses. These have nice and maximum selectivity regarding structure specific interaction. Also, these increases the blood flow time, which increases the half of existence of medication. But, these movementsdepend on the fictionalization application.^[6]

Meaning

Theranostics is the time period, which consists a mixture of therapeutics and diagnostics which is helpful for men or women medication. This theranostic concept even though is not a old concept, but its newly designed terms suggests advanced, amazing, strong effect over the nanoparticle devices which are capable of satisfying the patient convenience and also beneficial to doctors for treatment purpose. Those Nanotheranostics disciplines of slicing edge medicinal drug that consist nanoparticles, have wide variety of application for the treatment and diagnosis purpose. It determines the localization disorder state below study of the capacity therapeutic agent. Also, monitors the reaction of remedy and bio-distribution of that drug molecule which tells about drug efficacy and their safety. Those theranostics disciplines have been advanced over the nanoparticles but those theranostics have special characteristics to shape the novel nanoparticle which has absolute range than the conventional medicinal drug area and those novel nanoparticle which have a superior effect than traditional therapy.^[7]

New era nanoparticles are very much like older nanoparticles but suggest a difference in potency, efficacy, mode of action their duration of movement etc.

Nanotheranostics is nothing, but the utility of nanotechnology to theranostics having each diagnostic in addition to therapeutic strategies. It is a novel drug delivery system which is robust and advanced drug delivery device than nanoparticles, which opens the new direction for distinct medicinal discipline. The path has the capability to develop more efficacious medicinal fields in treatment of various severe disorder conditions.

These theranostic have beneficial effects over the healthcare as well as pharmaceutical industries. The beneficial effect is that, it increases a strong multifunctional plant shape for development of drug delivery machine which have the brilliant potential to live in a place. This can be very quiet simple to develop any sturdy emerging medicinal subject on the side of effectiveness and right remedy. Further, will be showing their empowerment in various disciplines of medicine.^[8]

Definition

Nanoparticles are ultrafine particles which range between the sizes of 1 to 100 nanometer diameter. The ranostics is a novel drug delivery machine which especially is advanced than the unconventional drug delivery device. Nanotheranostics is the technique, with the aid of which superior shape of nanoparticles are developed that have more potency than nanoparticles. Nanotheranostics is the aggregate of the diagnostics and therapeutics. These Nanotheranostics means improvement of nano length particle which is having capacity to deal with and diagnose the ailment circumstance simultaneously. Theranostics have the

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ability to broaden superior nanoparticles like gold nanoparticles, silver nanoparticle, magnetic nanoparticles, and polymer nanoparticles etc. which are more superior to the nanoparticles.

Uses

1. Nanotheranostics used in differential treatments like...

A. Diagnostic purpose:

I. Photodynamic treatments

II. Photo thermal remedies

III. Radiation treatments

IV. Gene treatment plans

B. Therapeutic purpose:

V. Chemotherapy

VI. Optical fluorescence

VII. Photo acoustic imaging

VIII. Magnetic resonance imaging

IX. Computed tomography

X. Positron emission tomography

2. Theranostics are used in personalized medication purpose.

3. Theranostics are used as molecular sensors for ailment analysis and remedy.

4. Act as a healing agent for an effective remedy.

5. Theranostics also have relevance in plant cells and tissues.

6. In the development of the more superior nanoparticles like silver, polymer nanoparticles etc.

7. Theranostics are applicable superiorly in the remedy of cancer circumstance like tumor cancer, breast cancer etc.

8. Theranostics are especially used in the remedy of targeted drug delivery as well as controlled drug delivery.

9. Also, useful in the remedy of neurodegenerative disease like Alzheimer's sickness, Parkinson's disease.

10. Useful in the development of superior novel drug delivery device.

Types of Theranostics Nanomedicines

1. Gold-Based Nanoparticles

These gold based nanoparticles have been investigated as multifunctional probes because of their high rank biocompatibility and well established strategies which are suitable for surface modification. Gold nanoparticles, not only applied as sensing utilities, it can also be used to induce photo thermal effects for therapeutics purposes due to their photo thermal and unique optical characteristics. Via gold-thiol bonding this Gold nanoparticles simultaneously carry therapeutics and diagnostics on their surface by providing a versatile platform.^[1]

2. Drug-Polymer Conjugates

Due to covalent interactions, using various chemical pathways Drug-polymer conjugates are made which largely depend on polymeric carrier, drugs functional groups that are included in chemical conjugations. Protein conjugates and drug conjugates with appropriate polymerase are two major types of conjugates.^[8]

3. Polymeric Nanoparticles

For many therapies, Polymeric nanoparticles have widely used. To prolong the circulation half-life, polymeric blocks were used due to lower phagocytic uptake. Because of storage stability, loaded drug protection/ diagnostic agent, biocompatibility and sustained release, "polymeric nanoparticles are nowadays used in applications of theranostics for targeted co-delivery of diagnostic and therapeutic agent".^[8]

4. Magnetic Nanoparticles

Iron oxide nanoparticles are magnetic nanoparticles which are made from magnetite or hematite. Due to super paramagnetic effects and acceptable bio-compatibility and cost effectiveness, iron oxides are highly used.^[2] The most commonly used nanomaterials are super paramagnetic iron oxide nanoparticles (IONPs), mainly magnetite and maghemite.^[1]

5. Solid Lipid Nanoparticles

For conventional emulsions, liposomes, and polymeric nanoparticles for intravascular delivery, solid lipid nanoparticles are an effective and safe alternative colloidal matrix carrier. From biocompatible lipids, solid lipid nanoparticles are prepared. They are used as a nanomedicine. At room temperature, solid lipid nanoparticles are in solid form.^[8]

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6. Dendrimers

Dendrimers from 10 to 100nm are usually used. This is synthetic nanomedicine. Dendrimers contains hugely branch spherical polymer. Dendrimers may be synthesized as convergent synthesis or divergent synthesis.^[8]

7. Carbon Nanomaterials

Carbon nanomaterials may be classified into carbon dot, zero-dimensional fullerene, two grapheme, one-dimensional carbon nanotube and Nanodiamond which are based on their bonding structures (sp2/sp3). Each possesses exceptional chemical and physical properties.^[1]

8. Micelles

Micelles are less than 100nm in size and have a narrow size distribution. They have a self-assembling colloidal structure with a hydrophilic shell and hydrophobic core. For parenteral administration of poorly water-soluble materials, micelles are another safer alternative. On strong cohesive force between drug and polymer core as well as cross linking of the shell or core, the stability of micelles is decided. Micelles are generally made by organic solvent method and direct dissolution method. In the hydrophobic core of micelles, therapeutic/diagnostic agents may be loaded and the outer hydrophilic layer with targeting agent, which may then be administered intravenously.^[8]

9. Liposomes

Liposomes differ in size, but most are 400 nm or less. They are spherical. Because of their size, biodegradability, biocompatibility, hydrophilic and hydrophobic character, low toxicity and immunogenicity, liposomes are effective platforms for drug/diagnostic delivery.^[8]

Advantages^[8,9,10,11]

Nanotheranostics help to anticipate therapeutic responses and monitor the patient's clinical evolution.

Nanotheranostics are used in diagnosis and treatment of solid tumors at an early stage.

Nanotheranostics system can allow higher drug bioavailability, local targeting and reduced toxicity to healthy tissue in head and neck cancers.

Nanotheranostics system has ability in both diagnostic and therapeutic activity for drug delivery, photo thermal therapy.

It allows large surface area and produces high stability and biocompatibility.

Nanotheranostics provide new approaches for diagnostic and treatment of different clinical and historical features in thyroid cancer.

In Nanotheranostics, Carbon nanotubes produce ultrahigh functionalization and large surface area.

It has the high penetration capacity to biological barriers.

It contains easy electrostatic interactions with nucleic acids and high degree of porosity.

Nanotheranostics system is suitable for photodynamic therapy.

In this system, nanoparticles show non-invasiveness and no harmful effect of nonionizing radiation.

Nanotheranostics can promote synergistic and combinatorial therapy, multi-modality therapies, siRNA co-delivery and delivery across the blood brain barrier.

It provides personalized therapy along with prognosis, which makes fatal diseases treatable at the earliest stage.

It has a convenient synthesis process and precise size and shape control ability.

The advantage of theranostics nanomedicine is intracellular diagnosis and in vivo biodistribution for future generations.

It improves cellular uptake of agents and precise size and shape control ability.

Nanotheranostics system was used to shows more specific and individualized therapies for fatal diseases such as cancer, cardiovascular diseases, AIDS, diabetes and immune disorders. The advantage of Nanotheranostics system is to attach the imaging agents.

It helps to protect the drugs from degradation and shows multimodal applications such as targeting, therapies, diagnostics.

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Nanotheranostics system has developed the imaging and light based therapies to improve the local action and reduction of impact of chemotherapy in healthy breast tissue to reduce the size of tumors in breast cancer.

Disadvantages^[10,12,13]

Nanotheranostics can produce in vivo toxicity.

It has poor colloidal stability.

It contains high cost for large scale production.

It produces low drug loading efficiency.

In Nanotheranostics, gold nanoparticles contain a lack of standard protocols for translation into clinics.

It produces rapid clearance.

Most light-activated Nanotheranostics systems need excessive energy UV light so it outcomes in damaging living cells and tissues and poor penetration depth.

In Nanotheranostics system, there is difficulty in modifying the surface (e.g. Thiol groups)

It lacks in following the standard protocol so as to prepare high purity.

In Nanotheranostics system, batch-to-batch variation in manufacturing takes place.

It produces an imperfect sensitivity of diagnostic components.

It takes more time to complete the process and produces complexity.

Nanotheranostics produces a relatively low sensitivity.

CONCLUSION

In this review, the recent and novel developments of Nanotheranostics and technologies were studied and discussed. The study includes Nanotheranostics properties, their use in targeted drug delivery, robust technologies of thernostics, type of Nanotheranostics like gold nanoparticles, silver articles, liposomes, magnetic nanoparticles etc. and the beneficial use in cancer and tumor treatment. Also, a given idea personalized medication with diagnostics and therapeutic function. Target molecular biomarkers are an advanced design which contributes for cancer therapy to increase precision and effectiveness of treatment. Thus, we may say that the Nanotheranostics is a promising diagnostic tool that can be utilized in the treatment of various diseases.

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