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A Review on Nanomedicine in the Cancer Therapy

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Abstract

Nanotechnology has an incredible prospective in disease prevention, diagnostics, imaging techniques, and drug therapy. According to United States National Institutes of Health (NIH) nanomedicine is defined as a molecular-scale intervention for prevention, diagnosis, and treatment of diseases. Limitation of conventional cancer therapies led to the development and application of a number of nanotechnologies for safe and efficacious treatment of cancer also referred to as cancer nanomedicine. Significant technological advancements have been achieved in this field, but the main hurdle in the development of the nanomedicine becoming a new paradigm in cancer therapy comes from the complex and heterogenic biology of tumour, a partial understanding of nano–bio interactions and the challenges concerning chemistry, production and controls necessary for clinical translation and commercialization. In a Layman's term nanomedicine is the application of nanotechnology to medicine. The aim of nanomedicine is to overcome the needs in management and treatment of diseases through interventions at a nanoscale that associate with the operational level of biological macromolecules inside the cells. Although extensively applicable in the field of diagnosis and treatment of numerous diseases, nanomedicine has technically advanced in research focused on the diagnosis and treatment of cancer. Currently, the researchers are continuously focusing on the development of new nanomaterial, nanodevices, and nanoparticles with various applications for cancer therapy.

Keywords: Nanomedicine; Cancer nanotechnology; Oncological; Drug delivery; Cancer therapy

Introduction

The nanoparticles are intended to have a targeted drug delivery of active agents to the target cells for its treatment or as an imaging agent to the disease-target cells for the diagnosis. An assembly of different chemical components acts collectively to overcome biological barriers for the targeted delivery [1-9]. The designing of the nanoparticles should vary according to the functional requirements. The nanoscale permits for a high degree of diversity to facilitate the nanoparticles to address an equally diverse range of functional requirements. Subsequently, nanoparticles are now regarded as the appropriate vehicles for the treatment and diagnosis in healthcare, especially in the case of cancer disease management [10-17].

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Nanomedicine

The fundamental problems related with the delivery and various unnecessary *in vivo* transitions of proteins and drugs needs to be tackled presently to exploit the myriad of recognized therapeutics produced by the nanotechnology. Nanomedicine is one of the most promising applications of nanotechnology in the field of healthcare and medicine [17-30].

PEGylation (i.e. addition of polyethylene glycol (PEG) to proteins and drugs) is one of the promising methodologies for development of drug and it has the potential to revolutionise medicine by drastically improving the pk-pd profile of the administered drug [20,31-37]. Nanomedicines and PEGylation, the latest offshoots of **nanotechnology** has the potential for future advancement in the field of targeted drug delivery system, *in vivo* stability of the formulation and retention [22,38-45].

Nanomedicine for Treatment of Lung Cancer

Lung cancer is the 2nd most common cancer and the major cause of death in both men and women in the United States and rest of the world. Because of its diagnosis at an advanced stage, it is linked with a high rate of mortality in a majority of patients [46-55]. Currently, huge advances have been witnessed in the development and application of nanotechnology in the cancer diagnosis and therapy. This evolution has led to the development in the promising field of "cancer nanomedicine." Nanoparticle-based drug delivery systems have been widespread due to their potential bioavailability, *in vivo* stability, GI absorption, better solubility, sustained, modified and targeted delivery, and efficacy of various anticancer agents [55-62]. Currently, a number of nanocarrier formulations are used such as based on lipids, metal-based, magnetic, polymeric and branched polymeric, and mesoporous silica. In the case of lung cancer, nanoparticle-based therapeutics is being investigated in the diagnosis and treatment of primary, benign and metastatic tumors. The application and expansion of novel nanocarriers for drug delivery is a very challenging research filed, particularly for the delivery of advancing cancer therapies [63-70].

Nanomedicine as an Emerging Platform for Metastatic Lung Cancer Therapy

Metastatic lung cancer is one of the most common cancers with a high mortality rate worldwide. Currently, the treatment includes chemo-therapy and pathway-dependent therapy with the aim to block the growth and proliferation of these metastatic lesions [71-76]. Nanomedicine is a developing multidisciplinary field that deals with exceptional access to living cells/ tissues and assures the state of the art in cancer diagnosis and treatment. Development of nanomedicines as drug carriers (nanocarriers) that target tumour cells for therapy is based upon the principles in the fields of chemistry of the molecules, medicinal chemistry, physics, biology, and engineering [77-86]. Given the enthusiastic activity in the field as showed by more than 30 nanocarriers have already been approved for clinical use. Given the promise of current clinical outcomes in various studies, nanocarrier-based strategies are expected to soon have a great influence on cancer treatment and therapy. Novel nanomedicines may open new doors for therapeutic intervention carrying macromolecules such as RNAi and mRNA and the capability to edit the genome using the CRISPER/Cas9 system [87-98].

In order to create awareness among the people, group of physicians and consultants unite to form a **society** or an organization. The main aim of these societies is to counsel and create awareness among the victims of Cancer as well as healthy personnel. Major societies like **United Cancer Research Society** aims to improve public awareness in cancer health, preventing, detecting and treating this diseases and the advancement of quality standards to enhance patient care [98-104]. **Senologic International Society (SIS)** aims on bringing along the national societies of Senology around the world and improving the information and quality of cancer health assistance worldwide. **Canadian Society of Nephrology** aims to

deals with the physiology and diseases of the kidneys. **kidney cancer Association** charitable organization involved in providing support to cancer patients promoting the advances in the diagnosis and treatment of cancer diseases. The main objective of these societies is to disseminate the scientific knowledge to oncologists so that they can provide better service to the patients and work together to reduce the risk of cancer problems [105-113].

Open Access literature plays a key role in proving the information and current researches across the globe. **Journal of Lung Cancer Diagnosis & Treatment** aims to provide individuals and organizations with the most recent information on methods to prevent Lung most cancers, epidemiology, and views on what reasons lung cancer, pathology, medical assessment, surgical procedure, chemotherapy, radiotherapy and other remedy modalities and also many conferences like Global submit on **Cancer Diagnostics** where an abstract entitled Smoking Cessation in Lung Cancer illustrated The greatest risk factor for **lung cancer** is smoking. Smoking addiction is one of the challenging problems that should be solved in lung cancer patients [114-120]. Including lung cancer, in cancer patients, quitting smoking has several benefits. However, implementation of smoking cessation clinics in oncology practices is inadequate and many lung cancer patients still smoke despite cancer diagnosis. **Journal of Cancer Science & Therapy** is an open access **peer reviewed** journal serving the International Scientific Community. This journal offers an **open access** platform to the authors to publish their research outcome and thus help in promoting Cancer and Oncology research.

Journal of Clinical & Experimental Oncology is a leading provider of information on cancer diseases and novel methods of treatment and diagnosis followed. The above mentioned Open access journals on cancer science & therapy are the peer-reviewed journals that maintain the quality and standard of the journal content, reviewer's agreement and respective editor's acceptance in order to publish an article. These journals ensures the barrier-free distribution of its content through online open access and thus helps in improving the citations for authors and attaining good **journal impact factors.**

Current Status and Future Direction of Nanomedicine: Focus on Advanced Biological and Medical Applications

Nanotechnology is the engineering and manipulation of materials and devices within the nanoscale range. Nanoparticles such as iron oxide, colloidal gold and quantum dot semiconductor nanocrystals have sizes generally ranging from 1 to 20 nm. These nanotechnologies have been immensely investigated in the past decade and had led to the development of a new area of "nanomedicine" which deals with the application of nanotechnology to human healthcare for therapy of a disease [120-127].

In the mid of 1990s, Doxil was approved by the USFDA, and now a number of nanomedicines are on the market and in the various phases of clinical trials. However, there are many obstacles in the human application of nanomaterials [128-135]. For translation to clinical use, a detailed insight is needed of the physocochemical properties of particles and their pk-pd behaviour in the body, like bio distribution, toxicity and biocompatibility.

Distinctive features of nanotechnology in oncological applications

- Improvement of the drug therapeutic index (TI) by escalating efficacy and/or Reduction in toxicities
- Specific delivery of drugs in a tissues, cells or organelle-specific manner
- Improvement of the pharmaceutical properties (for e.g. pk-pd properties, stability, solubility, circulating t-1/2 and tumor accumulation) of therapeutically active molecules
- Sustained or modified drug delivery system or stimulus-triggered drug release such as physical or chemical triggered drug release

- Enabling the delivery of biomacromolecular drugs like DNA, small interfering RNA (siRNA), mRNA and proteins) to targeted cells.
- Simultaneous delivery of multiple drugs to enhance the therapeutic efficacy and overcome drug resistance, by offering more specific control of the spatiotemporal exposure of each drug and the delivery of accurate drug ratio to the target of interest.
- Transcytosis transportation of drugs across tight epithelial and endothelial barriers (for e.g. GIT and the blood–brain barrier)
- Better sensitiveness towards cancer diagnosis and imaging
- Conception of sites of drug delivery by linking therapeutic agents with imaging molecules, and/or real-time feedback on the *in vivo* effectiveness of an active therapeutic agent.
- Potential technique for development of synthetic vaccines.
- Stimuli sensitive drug delivery system (for example, gold nanoshellsand nanorods, and iron oxide nanoparticles) upon stimulation

Apart from the articles, presentation at conferences, symposiums, workshops also yield a better exposure to health information and advanced technologies that are being invented in the present generation [136-142]. **16th Global Annual Oncologists Meeting** held in April 24-25, 2017 Dubai, UAE and **Oncologists Meeting** at Cologne, Germany will deal with Prevention, Diagnosis, and Treatment diseases of the Organ-related Cancers and its innovative techniques. **20th Euro-Global Summit on Cancer Therapy & Radiation Oncology** held in August 28-29, 2017 Brussels, Belgium. The conference may be prepared across the subject matter- Bridging the gap between Past, Present and Future Prospects of Anti-Cancer Therapies. It is a two day multidisciplinary meeting protecting all factors of Cancer Therapies and Radiation Oncology, consisting of clinical carrier delivery, management, informatics and research.

Global Summit on **Oncology & Cancer** held in May 25-27, 2017 Osaka, Japan. This Global Cancer Conference will have three days of discussions on methods and strategies related to management, quality improvement of Cancer as well as to explore the new ideas and concepts on global scale and the topics include lung cancer, breast cancer, bone cancer, blood cancer, cervical cancer, colon-rectum cancer, prostate cancer, thyroid cancer [143-149]. **World Congress on Preventive Oncology** July 20-21, 2017 Chicago, Illinois, USA, it will be organised by the theme: Exchange & Translation of scientific Information on preventive Oncology. Preventive Oncology is produced from many interactive clinical periods on one of kind sorts of cancers in addition to various diagnostic and therapeutic advancements on this subject. It is an initiative to unite the various research and enterprise communities running on this area below a one roof to discover every unmarried thing of cancer Diseases.

Conclusion

Like most of other scientific advancements that have revolutionized medicine over the past few decades, cancer nanomedicine must also be established before its full impact can be comprehended. Improving our understanding and knowledge of heterogeneity of tumor and recognizing EPR markers will enable selection of patients maximally responsive to nanomedicines [150-159]. A comprehensive knowledge of nano–bio interactions, systemic transport of nanoparticles to tumor cells and targeting them to the premetastatic niche can provide safer and more efficacious nanotherapeutics. There have been some major breakthroughs recently in cancer biology, but these have not necessary led to development of cancer-specific nanotherapeutics. Nanotechnology can maintain current cytotoxic therapies by increasing their tumor-

targeting potential and decreasing systemic toxicity. Many of the cancer nanotherapeutics also necessitate intracellular and subcellular localization for better efficacy [30-34,160-164]. Passive and active targeted nanoparticles can facilitate the drug delivery and increase the residence time at the tumor mass. Enhancing the residence time is crucial in reducing drug resistance. Several types of combination therapies encapsulated in nanoparticles with the chrono modulation can also be envisaged. Numerous major challenges like overcoming cytotoxicity and delivery of macromolecules like siRNA can be realized. Moreover, utilizing the multifunctional nanosystems with both imaging and therapeutic components can support tailored cancer therapy [165-166].

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