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Treatment of Lung Cancer by Carbon Nanotubes

Bhuvnesh Kumar Singh
Department of Pharmacy
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

Abstract: ***Due to its elevated prevalence, the significance of early detection and the full management of lung cancer to most patients with this dangerous illness rises every day. Since they have fair damage, diagnosis and therapy are useful in assisting the nanoparticles. This report lays out that the negative effects of carbon nanotube (CNT) use, like swelling, fibrosis, and carcinogenesis, are very troublesome in this disease treatment process. Utilizing strategies like functionalizing to the right dimensions as a longer length, greater width, with greater curvature, toxicity can decrease to a certain degree. Different modified vapours can be linked to the specific CNT sensors. In this respect, imaging enables non-invasive detection achievable with the aid of this process. Studies have also suggested that nanomaterials like CNTs may be used, particularly with chemotherapeutic agents, as carriers for direct drug delivery. For cancer cells targeting, most of these carrier were multi-wall carbon nanotubes (MWCNT) utilized. In the area of diagnosis and treatment, the findings of lab and testing on animals have been very beneficial and optimistic. The reviewed series of research highlighted the need for a thorough evaluation involving the CNT dosage, length, induction process, etc., in order to obtain the most controlled situations for human and animal studies. Four conflicting topics are addressed in the discussion section, which encourages investigators to do further studies to get clear results.***

Keywords: Carbon Nanotubes (CNTs), Diagnosis, Nano-Drug Delivery, Volatile Organic Components (VOC)

INTRODUCTION

The most important explanation for mortality from cancer wherein females became more affected is lung cancer. In addition, a latest review article reported that the 2nd most frequent cancer in humankind is lung cancer. This cancer is also estimated to have killed due to its silenced growth. Two major type of lung cancer are non-small and small cell lung cancer. Methodologies such as radiation, chemotherapy, and various drugs have been tried to cure lung cancer. Because of the non-targeted and unhealthy healthy tissues like hair follicles, these approaches were not highly successful. Depending on these methods, there will be disruption to the cell cycle, breakdown of the double DNA strands, inflammatory responses, tissue fibrosis, etc. On the other hand, a number of treatment barriers have been identified: low stability, solid solubility in water, and cell tolerance to chemo treatment. Eventually, the latest findings accomplishments, named nano-drug delivery as a new cancer therapy technique, were reported in a review article in 2017. A modern approach to care arose with the introduction of nanoparticles to explore genuineness and efficacy of treatment. However, even with the use of specific antibodies to connect to cancer cells, tumour targeting has several challenges; hence, the involvement of specialist in this area is required. Pulmonary tumours, however, are among the unstoppable cancer forms that scientists are working on to mitigate this problem [1].

For delivery systems and better health care, multiple nanocarriers such as liposomes, dendrimers, polymeric micelles, carbon nanotubes (CNTs), gold nanoparticles, magnetic nanoparticles, solid lipid nanocapsule, and inhalable nanocomposite have been utilized. In addition, a number of nanoparticles were quantum dot, gold nanoparticle, CNT, and magnetic nanoparticle that could be used to diagnose lung cancer. Scientists have utilized CNTs to identify and treat cancers like prostate, colon, breast, liver, lung, etc. Indeed, the CNT configuration described in the carbon atoms was put in a honeycomb pattern side by side, forming a tube of high physicochemical power [2].

In other words, CNT are referred to as carbon tubes that are nanometer-sized. The measurements of CNTs are represented in different ratios with diameters of 10-15 nm. In addition, two long CNT length scales are synthesised at 544 ± 231 nm and 10,450 ± 8423 nm, and shorter lengths of low toxicity are synthesised at 191nm. CNT are often classified into two classes of nanotubes that are single-walled (SW) and multi-walled (MW), and they have different dimensions. Due to their thermal conductivity, electrical property, strengths, and superior toughness, CNT are widely used in various areas. Currently, CNT are used for delivery systems, biomedical applications, genetic modification, tissue engineering, visualization, cancer therapy, antioxidant activity, bio-sensing, etc.

CNT are currently produced in 5 ways, defined as procedures of arc discharge, laser ablation, chemical vapour deposition, flame synthesis, and silane solutions. CNT are also filtered in three forms, such as air oxidation, sonication, and refluxing of acid. CNT, on the other hand, are an interesting compound which can be used to attach protein, peptide, nucleic acid, and several medicines. Additionally, because of the tubes and fiber-like design, CNT have a higher potential for drug delivery. The usable techniques to evaluate the CNTs and drugs with each other were collected as transmission electron microscopy (TEM), scanning electron microscopy (SEM), Raman spectroscopy, Fourier transforms infrared spectroscopy (FTIR), and X-ray diffraction (XRD), etc. As Raman spectroscopy, scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), transmission electron microscopy (TEM), and X-ray diffraction (XRD), etc., are the available techniques for comparing the CNTs and drugs [3].

However, in rats with a history of prior pulmonary diseases, the adverse reactions of pulmonary fibrosis and exacerbation were found when this method was used. In the "CNTs toxicity evaluation" portion, the toxicity of these carrier is carefully assessed. On the other hand, because of their extreme light absorption in biological imaging, a review article stated that the CNT are easily identifiable and invisible. Some characteristics of functional MWCNTs have been their detectability in the triggered area by multiphoton near-infrared imaging.

No analysis on the choice of using or not using CNT has been performed. In this report, the efficacy of these nanotubes is addressed while listing the drawbacks. In comparison, most conventional therapies have too much of a damaging effect than this procedure. It is, therefore, suggested that to improve performance, the tissue compatibility of nanotubes should be improved. The efficacy of these approaches in humans has been debated, in view of the compilation and classification of alternative techniques of management and therapy of lung cancer with CNTs. In addition, some of the accomplishments of this report are the methods to minimize the harmful effects of these CNT that could be beneficial in improving Nanomedicines. Also, all medications and compounds used by specialists owing to their style of study are described in this paper.

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DISCUSSIONS

Diagnosis of Lung Cancer by CNTs

In particular, the clinical symptoms of lung cancer involves tiredness, cough, sniffling, abdominal pain, and breathlessness, difficulty with eating, distress, and yellow fingertips. In addition, four techniques with the name of radiological, non-radiological imagery like MRI, endoscopic, and biochemical techniques can be used to diagnose lung cancer. CT scan screening typically carries out the detection, type, and level of lung cancer. Low-dose CT scans can, sadly, offer false-positive results regarding lung cancer. Currently, for lung cancer, the biomarkers of both proteins and genetic changes are identified. For non-invasive detection, multiple biosensors have been examined to attach to such biomarkers. A new and practiced technique is the identification of VOCs and tumour markers through breath analysis with CNTs support.

The sensor array of CNT revealed a difference in the volatile organic components (VOC) between the healthy and patient respiratory samples. The incidence of these compounds elevated in patients infected by lung cancer due to mass-spectroscopy and gas-chromatography. Because of solubility, polarity, and chemical interactions, the sensors address multiple biomarkers, particularly for tuberculosis disease. An affordable and easy approach was the creation of an electronic nose with CNT to remove the VOC of patients with lung cancer. The polar vapour biomarkers for lung cancer have been identified to be water, methanol, isopropanol, ethanol, acetone, 2-butanone, and propanol. Non-polar vapours have been identified to be chloroform, benzene, o-xylene, n-decane, 1-hexene, toluene, styrene, n-propane, cyclohexane, 1, 2, 4-trimethyl benzene and isoprene. As cancer biomarkers, SWCNTs, which are covered with nonpolymeric organic materials, may identify VOC modifications. This approach was a simple, non-invasive, affordable, and efficient test for the diagnosis of lung cancer biomarkers.

The SWCNT was designed and synthesized with tricosane and pentadecane in this study to provide a high sensitivity to nonpolar and VOC substances for diagnoses. CNTs, drugged with platinum, was able to detect the vapours of styrene and benzene that were present in patients with lung cancer exhalation. In natural nanotubes, this sensitivity was very low. For the identification of toluene gas as an indication of lung cancer, SWCNTs covered with Pd, Pt, Ru, or Rh components might be used. Even though the resistance of CNTs sensor to nonpolar VOCs was poor, the detection was limited. The presence of Hexa-peri-hexabenzocoronene derivative can enhance this sensor performance. A research performed in 2018 showed that a CNT biosensor were developed which can differentiate and accumulate C_6H_7N and C_6H_6 in the exhaled breath of lung cancer patients doped with Rh. In another report, it was stated that infrared CNTs could diagnose o-toluidine and aniline as 2 main gases in lung cancer.

In addition, a specific chemoresistive sensor was developed for cancer-related hexanal VOC utilizing molecularly imprinted polymers and multiwalled carbon nanotubes. A mixture of SWCNT and chitosan was prepared as another scheme used to assist in the diagnosis of lung cancer. A nanotube-based electrode sensor for quantitative electrophysiological tracking of non-adherent cells has been illustrated variability in nicotinic acetylcholine receptors in normal and small lung cancer cells. In addition, nitrogen-filled CNTs, connected to iron, was able to recognise unique cancer cell microRNAs recognised as a responsive electrocatalysis biosensor. The variations in mRNAs and miRNAs were also expected to suggest pulmonary fibrosis in MWCNT-exposed people. As a response, the emergence of CNTs in the area of diagnosis of lung cancer has provided another direction in terms of the efficiency of such nanotubes in medicine. In addition, CNT were able to obtain the modification of micro RNAs and RNAs of cancer cell. By means of electrodes and electrical current, CNTs may build many biomarkers of lung cancer.

Treatment of Lung Cancer with CNTs

Despite all of the lung cancer research groups' attempts, several individuals still die annually for this cause. It is considered amongst the most leading causes of mortality; the nano treatment is a modern approach that researcher focuses on. By influencing mitochondrial organelles in cancerous cells, CNT themselves are efficacious in curing the disease, like activating the cell death pathways. In this regard, polyethylene glycol-attached CNTs may better concentrate on cancerous cells compositions that have the potential to boost nano-drug delivery efficiency. Due to the form of CNTs, medications, and proteins, studies are split in this section. In the existence of effective Lung Cancer medications, single-wall carbon nanotubes it has been commonly used in cancer treatment and drug delivery owing to the reduced toxicity of SWCNT as a carrier. However, serum and pulmonary inflammation also undergone biochemical improvements.

Paclitaxel

It is utilised as an anti-cancer drug that bound with SWCNTs alongside graphene oxide. This nanostructure increased the efficacy of cancerous cells in A549 and NCI-H460 and caused death. SWCNT enhanced with chitosan was another study to deliver this compound, leading to an improvement in vivo effectiveness. Also, to reach A549 cells, the coating of chitosan was mixed with hyaluronic acid.

TRAIL

Without a harmful effect on healthy cells, Apo2L or TRAIL is a protein that can attach to cancerous cell's receptors and cause cell death. In comparison, due to TRAIL and its high blood solubility, the existence of SWCNTs contributed to the proper distribution of this protein and rapid elimination of the pulmonary tumour.

Doxorubicin

Due to magnetic localization and better distribution, supplying doxorubicin with SWCNTs will improve targeting and maximize therapeutic performance. Indeed, the findings of increasing the efficiency of therapy by MRI technique were verified by this project conducted on mice [4].

Curcumin

It is a chemical developed that has therapeutic benefits for A549 cancer cells, was studied in a nano-state with a SWCNT carrier in a report in 2018. The medication's effectiveness was improved by the carrier, that was functional with chitosan and alginate polysaccharides.

Survivin siRNA and Doxorubicin

A 2019 study found that the use of survivin siRNA and doxorubicin with the SWCNT carriers were two factors that increased cell death and expressed less survivine as a cell death inhibitor gene. In addition to Betaine, the carrier was designed and synthesized with polyethyleneimine (PEI).

Gemcitabine

Even, for NSCLCs, Gemcitabine is one of the anti-cancer medications. The drug was evaluated with a SWCNT carrier in a clinical trial on B6-mice. The cell line of A549 was studied in this research, that reveals impressive findings in repression. In addition, owing to the increase loaded propensity of the medication, extended distribution period, and significant cell membrane permeability, this research has indicated SWCNTs as promoting carriers for drug delivery [5].

CONCLUSION

The use of nanotubes in the diagnosis and treatment of diseases has been considered to be an excellent tool. Furthermore, research have shown that the immune response in vivo also isn't uncommon. Scientists must, however, aim to improve the performance of certain carriers. The results also revealed that CNT therapy was much more effective and efficient than conventional therapies for this cancer. Surprisingly, scientists are quickly researching this form of treatment for cancer. Also, with lesser side effects, nanotubes with a greater range, greater breadth, and larger curvature may partially be achieved utilizing modern techniques like functionalization.

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