Perspective

Nanoparticles of biodegradable polymers for chemotherapy

Elena Lockwood

Lockwood E. Nanoparticles of biodegradable polymers for chemotherapy. Nanotechnol Lett.2022; 7(3):1-2.

ABSTRACT

More than 10 million people are diagnosed with cancer each year, making it the leading cause of death. Every year, cancer kills 6 million people worldwide, accounting for 12% of all fatalities. Since 1990, there have been nearly 16 million new cancer cases diagnosed in the United States, with 553,768 cancer fatalities. In 2002, about 1.3 million new cases of cancer were diagnosed, with over half a million fatalities from cancer, or one in every four deaths. In 1950, the death rate from cancer in the United States was 193.9 per 100,000, and it remained at 194.0 per 100,000 in 2001. It's a multidisciplinary problem that will require more and tighter collaboration between doctors, medical and biological scientists, and biomedical engineers to discover a solution. Emerging nanotechnology raises the possibility of substantial advances in the near future.

Key Words: *Anticancer drugs, Biomaterials, Blood-brain barrier, Cancer, Chemotherapeutic engineering, Controlled release, Drug delivery, Oral Chemotherapy, Paclitaxel, Targeted delivery.*

INTRODUCTION

Chemotherapy is a powerful treatment for cancer as well as other dangerous disorders like cardiovascular restenosis and AIDS. Chemotherapy is a difficult technique with numerous variables that influence its success or failure. It is associated with a greater risk of drug toxicity, with more effective drugs being more hazardous. Even with successful chemotherapy, there are still issues. Patients must put up with serious side effects and reduced quality of life. The inefficiency and side effects of chemotherapy are thought to be caused mostly by the formulation, pharmacokinetics, and toxicity of chemotherapeutic agents, as well as cancer cell drug resistance, as exemplified by paclitaxel, a common anticancer treatment (Taxol [R], Bristol-Myers Squibb).

Over the last decade, there has been a lot of study into developing biodegradable polymer nanoparticles as effective drug delivery vehicles for chemotherapy. The advancement of nanoparticle technology for chemotherapy has been aided by advances in nanoparticle technology, material science and engineering, and cellular and molecular physiology and pathology. The polymers utilized are biocompatible and biodegradable, both synthetic and natural, and have been approved by the FDA. The medicine might be distributed throughout the polymeric matrix or conjugated/attached to polymer molecules. The medicine can be released from the nanoparticles after administration. In addition to medication formulation, biodegradable polymer nanoparticles can be used to address pharmacokinetics, drug toxicity, and drug resistance in chemotherapy. To promote the concept of chemotherapy, it may include sustained, controlled, and targeted chemotherapy, personalized chemotherapy, and chemotherapy across various physiological drug barriers, such as the GI barrier for oral chemotherapy and the blood-brain barrier (BBB) for the treatment of brain tumours and other CNS diseases, and, eventually, chemotherapy at home.

Nanoparticle Formulation

Polymeric nanoparticles can be made by dispersing polymers or polymerizing monomers, both of which require the use of chemical engineering techniques. Polylactic acid (PLA), polylactic-co-glycolic acid (PLGA), and polyepsilon-caprolactone (PCL) are among the FDA-approved biodegradable and biocompatible polymers available for this purpose. The polymer is dissolved in an organic solvent such as dichloromethane, chloroform, or ethyl acetate in the polymer dispersion process. If the anticancer medicine is hydrophilic, the procedure should be tweaked slightly to produce a water-in-oil-in-water emulsion. The generated particles are collected by centrifugation or filtering and then freeze-dried to create powders for storage. The polymer type and molecular weight, the copolymer blend ratio, the kind of organic solvent, the medication loading amount, the emulsifier/stabilizer/additive utilized, the oil-to-water phase ratio, the mechanical strength of mixing, temperature, and pH are all controlling factors in the formulation process. The polymer type, molecular weight, and copolymer blend ratio all play a role in determining the nanoparticles' degradation/erosion rate and are thus essential parameters for in vitro and in vivo drug release.

Editorial Board office Nanotechnology Letters, UK

Correspondence: Elena Lockwood, Editorial Board office, Nanotechnology Letters, UK, E-mail- letters@asiameets.com

Received: 02-May-2022, Manuscript No. pulnl-22-5069; Editor assigned: 04-May-2022, Pre QC No. pulnl-22-5069 (PQ); Reviewed: 18-May-2022, QC No. pulnl-22-5069 (Q); Revised: 20-May-2022, Manuscript No. pulnl-22-5069 (R); Published: 27-May-2022, DOI: 10.37532/pulnl.22.7(3).1-2

Nanoparticle Characterization

To characterize drug-loaded nanoparticles of biodegradable polymers, a variety of cutting-edge approaches can be used. The nanoparticles' size and size distribution are important factors in determining their destination and therapeutic effects after delivery. Nanoparticles have a higher surface area to weight or volume ratio than bigger particles, which is one of their advantages. This makes drug release from nanoparticles easier. The size and size distribution are also critical in determining how they interact with the cell membrane and how well they penetrate physiological drug barriers. Laser light scattering and other particle analyzers can be used to measure these. To incorporate the desired release kinetics in the design of chemotherapy, a mixture of nanoparticles of various sizes can be used. The therapeutic effects of the released drug against those of the free drug under the same administration settings can be used to assess the performance of the drug-loaded nanoparticles. The physicochemical features of the drug within the nanoparticles could be used to determine whether or not the nanoparticles are suitable for chemotherapy. The majority of anticancer medicines are physicochemically stable. In comparison to the raw drug, a differential scanning calorimetry (DSC) study revealed that paclitaxel within the PLGA nanoparticles is in its amorphous condition, with no significant change in the thermogram. Other physicochemical features of the medication enclosed in the polymer matrix should be examined further as well.

Key Challenges

In chemotherapy, pharmacokinetics is a critical factor. The cancer cells must be exposed to a sufficiently high concentration of the medicine for an extended period of time. Chemotherapy is currently administered on an as-needed basis, with injections or infusions occurring on a regular basis. To allow for patient recovery, there must be a break between treatment cycles. This permits tumour blood vessels to develop quickly, compromising the therapeutic effects. Severe side effects are caused by the high peak medication concentration. Long-term exposure to the drug at low concentrations is thought to be more beneficial than a high-concentration pulsed dose. Chemotherapy's ideal goal is to deliver high-efficacy medications at the appropriate time to the right region at a high concentration while remaining safe. Drug resistance is another important issue that must be addressed at the vascular, interstitial, and cellular levels in order to achieve successful treatment. Drug transport through tumour microvessels can occur via interendothelial junctions and Trans endothelial channels. The pore cutoff size of numerous tumour models was discovered to be in the range of 380 nm to 780 nm.

The tumour interstitium has a high hydrostatic pressure, which induces medication resistance by causing an outward convective interstitial flow. Tumour resistance to treatment drugs is influenced by cellular processes such as changes in particular enzyme activity or apoptotic regulation, as well as transport-based systems such as the. Nanoparticles may be able to tackle the problem of drug resistance due to their small size and proper surface coating. In chemotherapy, oral administration of anticancer medicines is a challenge. Anticancer medications delivered orally may improve efficacy and lessen adverse effects, in addition to being more convenient for patients. Oral delivery allows cancer cells to be exposed to a safe but effective medication concentration for a longer period of time, potentially resulting in better efficacy and fewer adverse effects than injection/infusion. Most anticancer medicines, unfortunately, are not bioavailable. Paclitaxel, for example, has a bioavailability of less than 1%. The reason for this is that the medication would be removed by cytochrome P450 and the efflux pump P-gap during the first metabolic phase. To make oral chemotherapy possible, therapeutic methods using P450/P-GP suppressors such as cyclosporine A are now being investigated. Anticancer medications delivered orally make it possible for patients to do their own chemotherapy at home, improving their quality of life significantly.

Five-Year View

For this reason, more and better biodegradable polymers will become available, such as those for surface erosion and those with the appropriate hydrophobicity-hydrophilicity balance. The nanoparticle technology will be fine-tuned to produce smaller nanoparticles with the necessary surface modification. The use of nanoparticles to target cancer cells will be studied more thoroughly. Some targeted methods, such as ligand-receptor interaction, may become feasible. At the molecular level, the interaction between drug and polymer within the polymeric matrix, as well as that between nanoparticles and normal/cancer cells, will be elucidated. In the next five years, we should expect breakthroughs in nanoparticle formulation of antiproliferative/antiplatelet/anticoagulant medications for cardiovascular restenosis and antiviral compounds for AIDS treatment.

Nanoparticle formulation for new, more effective anti-cancer drugs will be required as part of the drug research process. In the next five years, chemotherapeutic engineering will be clearly defined and will begin to play an essential and vital role in the battle against cancer and other fatal diseases.