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Editorial

Nanomedicine for Treatment of Cancer

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Cancer is one of the most deadly diseases faced for the human society, causing deaths of millions of patients. [1] After decades of research efforts to find the effective ways of battling against cancer, doctors now have plenty of methods such as chemotherapy, radiotherapy and curative surgery to kill cancer cells and control the progression of cancers. [2, 3] However, due to the inherent complexity of cancer, it is still a tough task for scientists to truly cure cancer. Among all of therapeutics, chemotherapy is still playing an essential role as seen by the large quantity of prescriptions of chemotherapeutic drugs used in clinic annually. In spite of the fact that many patients can benefit from traditional chemo treatments, the strong toxicity, poor tissue selectivity, narrow therapeutic windows and related drug resistance greatly limit the use of chemotherapeutic drugs and worsen the life quality of cancer patients.[4] Most toxicity of chemotherapy is related to the off-targeting of highly cytotoxic compounds, which result in the death of healthy tissue cells and malfunctioning of normal physiological signaling pathway.

The concept of "magic bullet" was developed by German Nobel laureate Paul Ehrlich over 100 years ago, which can be simply stated as the selective delivery of active drug to diseased tissues. [5] Theoretically, the precise delivery of drug would allow less usage of pharmaceutical agents with the elimination of side effects caused by off-targeting, therefore holding the promise to overcome and cure cancer.

While traditional pharmaceutical technology can only produce delivery particles of micrometer size and limited capability to modification the surface, the advancement in nanotechnology has provided scientists with great powers to fabricate nanoparticles of different sizes and properties for various objectives. From either top-down or bottom-up methods, scientists are now able to prepare nanoparticles with specific shapes, sizes and chemical-physical properties both inside and outside. Also, emerging techniques are showing promises on characterizing drug loadings onto these nanoparticles. [6, 7] For cancer therapy, nanoparticles are showing the "enhanced permeability and retention effect" (EPR) which permitted nanosized particles to specifically target and accumulate in the tumor cells due to the more leaky nature of tumor vasculature.

Both non-covalent encapsulation and covalent conjugation have been exploited to load the active drugs. In non-covalent encapsulation, drug molecules are loaded in the nanoparticles by non-covalent bonding such as hydrogen bonding and π-π interaction, which offers the advantages of adjusting the dosage ratio accordingly and sometimes being able to deliver multi drugs as combination therapy to improve the efficiency of cancer treatment.[8]On the other hand, the weak non-covalent nature would normally lead to instability in releasing kinetics, causing burst release of drugs and the imprecise drug loadings percentage. As comparison, covalent conjugates, in which both drugs and materials are chemically bonded together, enable the delivery vehicle a predictable releasing profile, which can be adjusted by either the concentration of conjugates or the amounts of drugs attached. [9-11].

One of the most successful examples has been set by Abraxane® which use albumin as delivery vehicles for paclitaxel. [12] Paclitaxel is a drug from Taxane family to suppress microtubule dynamics during cancer cell division. Abraxane® has an average nanoparticle size of about 130 nm and been approved U.S. Food and Drug Administration (FDA) for the treatment of breast cancer, lung cancer and pancreatic cancer. Meanwhile, more than 200 nanomedicines are either approved or in different stages of clinical trials.

While great achievements have been accomplished in nanomedicine, it is still essential for scientists to address other

critical issues related to nanomedicine and its application in cancer therapy such as the smart choice of biocompatible materials, the immunological response from delivery vehicles and the potential systemic toxicities of nanosized medicines.[13]

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