Research and Reviews: Drug Delivery

Drug Delivery: Current Advances and Opportunities

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Editorial

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EDITORIAL

Pharmacological intervention is available for nearly all health-related conditions; however, severe and at times irreversible damage to various healthy tissues is a major health problem worldwide and remains the single most important complication of treatment as it may limit further treatment or even threaten life. To address this important issue, tremendous effort has been undertaken over the past three decades to develop novel drug delivery systems that relieve these life threatening side effects and ultimately improve long-term outcomes. Collectively, these efforts have resulted in the FDA-approval of several biopharmaceutical products including monoclonal antibodies, recombinant proteins, vaccines, and new formulations of classic therapeutics that are delivered using highly innovative technologies including nanoparticles, depot and jet injection, or transdermal methods among others. The promise of drug delivery systems is higher specificity and potency with reduced side effects; several state-of-the-art delivery technologies are clinically implemented, all of these systems have unique advantages and limitations [1].

According to the National Institute of Biomedical Imaging and Bioengineering, current research efforts in drug delivery primarily focus on routes of delivery, delivery vehicle, cargo, and targeting strategies. Alternative routes of drug administration being explored include pulmonary [2], nasal [3], oral [4], transdermal [5,6], vaginal [7] and ocular [8] which offer the advantage of being relatively painless [9] though there are limitations that must be overcome in order to reach their clinical potential. Nanotechnology is the main driving force behind the discovery of new drug delivery vehicles, with liposome based delivery systems being the most successful form of nanomedicine to date [10]. Besides classic chemotherapeutics, researchers are revisiting therapeutics that were once highly promising agents that ultimately failed in clinical development and new therapeutics [11], such as vaccines [12] and siRNA [13,14], as cargo. Targeted drug delivery is an essential criterion in the development of new delivery systems to avoid detrimental side effects to healthy tissues and increase efficacy. A variety of approaches have been considered to specifically target therapeutics and can be achieved through passive [15] or active [16] mechanisms. Passive mechanisms have been the most widely investigated in regard to targeting tumors and are primarily achieved through the enhanced permeability and retention effect which takes advantage of unique pathophysiological characteristics associated with solid tumors that are not observed in normal tissues or organs [15]. In contrast, active targeting mechanisms are achieved through specific properties of target cells, such as cell surface markers or transporters that facilitate active uptake [16]. Another mechanism to achieve controlled, localized delivery is integration of a trigger mechanism whereby cargo is released in response to an environmental trigger, such as pH [17,18] or applied for instance, ultrasound [19-21], UV light [22,23] and temperature [24,25].

CONCLUSION

Drug delivery research is extremely active, this translational field of medicine has made tremendous advances over the past three decades associated with formulation, novel delivery strategies and overcoming biological barriers that have positively impacted patients afflicted with a variety of conditions. However, challenges still remain and more research is necessary to refine current drug delivery systems that primarily focus on crossing the blood-brain barrier in brain diseases and disorders, enhancement of intracellular delivery, and theranostics, a new strategy for combining diagnostics with treatment in one step. To address these challenges, investigators must take an interdisciplinary approach uniting physical and engineering sciences with biological and pharmaceutical sciences among other disciplines to advance basic research and resolve these challenges with the ultimate goal of translating revolutionary discoveries into health benefits.

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