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Nanomedicines, Should We Be Distinguishing.....?

Nawal khalafallah*

Department of Pharmaceutics, Egypt

***Corresponding author:** Nawal khalafallah, Department of Pharmaceutics, Faculty of Pharmacy, Alexandria University, Alexandria, Egypt

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Introduction

With the increase in nano-medicines reaching market approval, two formulation strategies are evident. In one approach, the drug itself is presented as nano-size particles prepared either by high shear homogenization of larger particles or by building up drug molecules into nano-sized entities. In the second approach, the drug is loaded into a nano-sized carrier (lipid or polymer, biodegradable or not, vesicular, particulate or capsular).In both approaches, system stabilization against aggregation is necessary to maintain shelf life stability if the formulation is presented in a liquid form. When identifying the anticipated improved therapy outcomes of nano-medicines, it is probably prudent to distinguish between the two formulation approaches.

Taking an injectable nano-medicine as an example, and which contains drug alone as nano-particles (first approach), the nano-size imposes changes in drug bio-distribution compared to drug molecules in conventional injectables. The nano-sized drug particles may escape uptake by the RES if small enough, resulting in long duration in plasma. It is understood that drug candidates, in this case, are mostly hydrophobic in nature resisting rapid dissolution in plasma; otherwise, benefits of nanosize could be lost. Enhanced permeation and retention (EPR) or passive targeting can then result in preferential accumulation of drug nano-particles in target tissues such as tumors; the leaky tumor vasculature in this case is a key factor.

Looking at an injectable nano-medicine where the formulation consists of a nano-sized carrier loaded with drug. In most research papers handling such systems, the drug physical form after loading is usually described as non-crystalline, based for example, on DSC data showing disappearance of the melting drug peak in the loaded carrier. Are we dealing here with drug molecules entrapped within the nano-sized carrier? The alternative is nano-sized amorphous drug particles within carrier nano-particles.

Drug physical form when loaded in carrier nano-particles must be considered when discussing improved therapeutic efficiency compared to drug molecules alone. If the carrier nano-particles rapidly release their drug payload, as molecules, into the circulation after injection, we should not anticipate changes in drug pharmacokinetics and bio-distribution. In the majority of cases, however, the nano-carrier exerts a degree of control over drug release. In addition, active targeting through attachment of specific entities to the surface of the carrier can promote accumulation in target tissues.

One aspect of nano-medicines so far appearing common with both formulation approaches is the notion that such nano-particles (drug nano-particles or carrier with drug payload) can be taken up by cells, contrary to previous belief that cellular uptake is restricted to molecular entities. Cellular uptake and permeation data in published cell culture literature often point to selective cellular uptake of the nano-particles themselves into target cells while demonstrating reduced cellular uptake in toxicity studies involving other cell lines.

The possible direct cellular uptake of nano-particles bypassing a drug release step into surrounding medium has extended to the oral route; the data in this case indicate enhanced bioavailability attributed to uptake of loaded nano-particles into the lymphatic system. The possible adhesion of nano-particles to the intestinal mucosa cell walls is sometimes claimed to contribute to enhanced uptake and improved bioavailability.