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Editorial Letter

Are the Benefits of Nanopharmaceuticals Outweighing their Potential Risks?

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Dear Editor-in-Chief

Nowadays, the use of nanoparticles has increased widely, as they are being applied in various fields, including cosmetics, textiles, medicine, and pharmaceuticals [1–3]. Nanoparticles have redefined the field of medicine due to their fascinating properties, such as target site specificity, enhanced solubility, and systemic stability [4]. Over the years, nanoparticles have been recommended as a breakthrough in modern science due to their diverse applications. In the field of medicine, nanoparticles have set a high standard by enabling the development of advanced therapeutic systems that have significantly contributed to disease management and improved human health [5]. However, despite these advancements, several challenges persist in realizing the full potential of nanoparticles, with toxicity being one of the most critical concerns requiring immediate attention [6,7]. Recent studies have revealed that nanoparticles can lead to significant deleterious effects when introduced into the body. The extent of these unwanted effects is influenced by several factors, including their physicochemical properties, size, aspect ratio, surface area, nanoparticle composition, shape, surface coating, and dissolution properties [8,9]. Additionally, the route of administration significantly influences the biological impact of nanoparticles, such as inhalation, which is the most common route, inducing lung inflammation by promoting systemic circulation through the bloodstream and lymphatic system [10]. Furthermore, dermal contact, often resulting from cosmetic products and topical treatments, represents another prominent pathway for nanoparticle penetration and dermal toxicity [11]. The primary mechanisms underlying nanoparticle toxicity are attributed to their small size and high surface area-to-mass ratio; their large surface area can facilitate the generation of free radicals, such as hydroxyl radicals and superoxide anions, potentially leading to oxidative stress [12]. This effect is particularly significant for metal-based nanoparticles, where oxidative stress is a critical contributor to nanoparticle toxicity. The production of reactive oxygen species is closely associated with the inflammatory responses triggered by nanoparticles. Therefore, the potential to generate reactive oxygen and nitrogen species induces cytotoxicity, genotoxicity, nephrotoxicity, hepatotoxicity, and neurotoxicity [13,14]. Therefore, conducting thorough safety assessments is essential to identify potential risks and implement preventive strategies to ensure their safe application in living systems [15]. Currently, limited data is available about the safety of specific types of nanoparticles used in the pharmaceutical field, highlighting the necessity of evaluating whether their benefits outweigh the potential risks before their introduction to the therapeutic market, which remains a priority for the pharmaceutical authorities. Thus, comprehensive toxicological studies are essential to provide a thorough evaluation of nanoparticles utilized in drug delivery systems.

Keywords: Benefits, Nanopharmaceuticals, Risks, Toxicity.

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