Anticancer Activity of Engineered Nanomaterials

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Abstract

Cancer is a leading cause of death worldwide, accounting for 7.6 million deaths (around 13 % of all deaths) in 2008. Even more serious is the recent projection by the World Health Organization (WHO), which anticipates total cancer cases to be over double by the year 2030. One of the major challenges in cancer therapy is to improve the selectivity and efficacy of anticancer agents and reduce their side effects to improve quality of life for cancer patients. With the rapid developments in nanotechnology and nanomaterials, new types of drugs are being explored that have the potential to overcome problems with existing anticancer therapies. Nanomaterials are increasingly being recognized for their potential applications in biomedicine such as imaging, drug/gene delivery and cancer therapy, due to their unique physicochemical properties. Recent preliminary studies suggested that some of the inorganic nanoparticles (NPs) have potential to induce toxicity in a cell-specific and proliferation-dependent manner with rapidly dividing cancer cells being the most susceptible and quiescent cells being the least sensitive. Clearly the type of cell in question is important when considering toxicity of some of NPs toward mammalian cells. We investigated whether ZnO and Fe_3O_4 NPs induced toxicity in a cell-specific manner and determine the possible mechanisms of toxicity caused by these NPs in cancer cells. We have utilized different types of cancer cells and normal cells. Results showed that both ZnO and Fe_3O_4 NPs exert distinct effects on cell viability via killing of cancer cells while posing no toxicity on normal cells. Molecular data suggested that NPs selectively induce apoptosis in cancer cells, which is likely to be mediated by reactive oxygen species via p53; bax/bcl-2 and caspase-3 pathways, through which most of the anticancer drugs trigger apoptosis. The present study warrants further investigation on anticancer activity of ZnO and Fe_3O_4 NPs in relevant animal models.

Keywords: Nanotechnology; Cancer therapy; ZnO; Fe_3O_4; Apoptosis