Toxicity Assessment of a Panel of Nanomaterials in Placental Barrier BeWo b30 Cells

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Metal nanoparticles (M-NP), inorganic non-metallic and carbon-based nanomaterials (CBM) are among the categories of nanomaterials (NM) of largest market volume [1]. The increasing number of products containing NM has raised serious concerns regarding their environmental and human safety. Biological barriers are important lines of defence to xenobiotics, thus expected targets for NM. One aspect that has been poorly addressed is the impact of NM on placental development and function. The present study aimed at evaluating the toxicity of NM of industrial, consumer and biomedical relevance in human BeWo clone b30 epithelial cells, a widely used model of placental trophoblastic cells.

BeWo b30 cells were exposed for 24 h to varied concentrations of NM of different chemical composition [Au, Ag, TiO2, SiO2 and graphene oxide (nano_GO)], primary size (10, 30 and 60 nm Au- and AgNP), capping (citrate- and PEGylated AuNP) and crystal structure (TiO2 NP rutile and anatase forms). In vitro cytotoxicity was assessed by determining changes in cell morphology, metabolic activity, plasma membrane integrity, intracellular reactive oxygen species and ATP levels. Genotoxicity (DNA strand breaks and oxidative damage) was also assessed.

No evident changes in cell morphology were observed after exposure to any tested NM. Overall, NM can be ranked for cytotoxicity as AgNP > nano_GO > AuNP ~TiO2 NP ~ SiO2 NP, being the effects more visible at higher concentrations. Regarding M-NP, the role of the size in the cytotoxic-induced effects was more evident for AgNP than for AuNP, with the smaller NP inducing more cytotoxicity in BeWo b30 cells. PEG capping was an effective capping agent for preventing the cytotoxic effects that were visible in cells exposed to the tested citrate-capped AuNP. No significant differences between rutile-anatase and anatase TiO2 NP-induced cytotoxicity were observed. Exposure to AgNP and nano_GO significantly increased ROS levels of the exposed cells suggesting that oxidative stress is a possible mechanism underlying their cytotoxicity in BeWo b30 cells. All tested NM significantly increased intracellular ATP levels compared to control cells, except for 10 nm AuNP. No significant changes in both DNA strand-breaks levels and DNA oxidative damage were detected for all tested NM.

Our findings alert for the potential risks associated with human placental exposure to NM, where the physicochemical properties are important drivers of toxicity. Additional research is needed for a deeper understanding of NM impact on human placental barrier and to unravel the properties responsible for NM-mediated toxicity, and thus support regulatory decisions that protect consumers and ultimately assist in the development of safer NM.

References

[1] Contado C. Front Chem. 2015; 6(3): 3-48.

Acknowledgments

This work was supported by the project NanoBioBarriers (PTDC/MED-TOX/31162/2017), co-financed by the Operational Program for Competitiveness and Internationalization (POCI) through European Regional Development Funds (FEDER/FNR) and the Foundation for Science and Technology (FCT/MCTES). Thanks are also due to FCT/MCTES for the financial support to EPIUnit and ITR (UIDB/04750/2020 and LA/P/0064/2020).