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Surface coatings alter transcriptional responses to silver nanoparticles following oral exposure

Sameera Nallanthighal [1 2], Lukas Tierney [3], Nathaniel C Cady [3], Thomas M Murray [3], Sridar V Chittur [1 2], Ramune Reliene [1 4]

Affiliations

Affiliations

1 Cancer Research Center, University at Albany, State University of New York, Rensselaer, NY, USA.
2 Department of Biomedical Sciences, University at Albany, State University of New York, Albany, NY, USA.
3 Colleges of Nanoscale Sciences and Engineering, SUNY Polytechnic Institute, Albany, NY, USA.
4 Department of Environmental Health Sciences, University at Albany, State University of New York, Albany, NY, USA.

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Abstract

Silver nanoparticles (AgNPs) are used in food packaging materials, dental care products and other consumer goods and can result in oral exposure. To determine whether AgNP coatings modulate transcriptional responses to AgNP exposure, we exposed mice orally to 20 nm citrate (cit)-coated AgNPs (cit-AgNPs) or polyvinylpyrrolidone (PVP)-coated AgNPs (PVP-AgNPs) at a 4 mg/kg dose for 7 consecutive days and analyzed changes in the expression of protein-coding genes and long noncoding RNAs (lncRNAs), a new class of regulatory RNAs, in the liver. We identified unique and common expression signatures of protein-coding and lncRNA genes, altered biological processes and signaling pathways, and coding-non-coding gene interactions for cit-AgNPs and PVP-AgNPs. Commonly regulated genes comprised only about 10 and 20 percent of all differentially expressed genes in PVP-AgNP and cit-AgNP exposed mice, respectively. Commonly regulated biological processes included glutathione metabolic process and cellular oxidant detoxification. Commonly regulated pathways included Keap-Nrf2, PPAR, MAPK and IL-6 signaling pathways. The coding-non-coding gene co-expression analysis revealed that protein-coding genes were co-expressed with a variable number of lncRNAs ranging from one to twenty three and may share functional roles with the protein-coding genes. PVP-AgNP exposure induced a more robust transcriptional response than cit-AgNP exposure characterized by more than two-fold higher number of differentially expressed both protein- coding and lncRNA genes. Our data demonstrate that the surface coating strongly modulates the spectrum and the number of differentially expressed genes after oral AgNP exposure. On the other hand, our data suggest that AgNP exposure can alter drug and chemical sensitivity, metabolic homeostasis and cancer risk irrespective of the coating type, warranting further investigations.

Keywords: Silver nanoparticles; in vivo; long noncoding RNA; mouse; transcriptomics.

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