Do inhaled carbon nanoparticles translocate directly into the circulation in man?

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Abstract

Rationale
Increased exposure to particulate air pollution (PM$_{10}$) is a risk factor for death and hospitalisation with cardiovascular disease. It has been suggested that the nanoparticulate component of PM$_{10}$ is capable of translocating into the circulation with the potential for direct effects on the vasculature.

Objective
The study aim was to determine the extent to which inhaled Technetium-99m ($^{99m}$Tc) labelled carbon nanoparticles (Technegas), were able to access the systemic circulation.

Methods and Main Results
Ten healthy volunteers inhaled Technegas and blood samples were taken sequentially over the following 6 hours. Technegas particles were 4-20 nm in diameter and aggregated to a median particle diameter of approximately 100 nm. Radioactivity was immediately detected in blood, with levels increasing over 60 minutes. Thin layer chromatography of whole blood identified a species that moved with the solvent front, corresponding to unbound $^{99m}$Tc-pertechnetate, which was excreted in urine. There was no evidence of particle-bound $^{99m}$Tc at the origin. Gamma camera images demonstrated high levels of Technegas retention (95.6±1.7% at 6 hours) in the lungs, with no accumulation of radioactivity detected over the liver or spleen.

Conclusions
The majority of $^{99m}$Tc-labelled carbon nanoparticles remain within the lung up to six hours after inhalation. In contrast to previous published studies, thin layer chromatography did not support the hypothesis that inhaled Technegas carbon nanoparticles pass directly from the lungs into the systemic circulation.