# Carbon nanoparticles stimulate blood clotting, researchers report

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Carbon nanoparticles – both those unleashed in the air by engine exhaust and the engineered structures thought to have great potential in medical applications – promote blood-clotting, scientists report in an upcoming edition of the *British Journal of Pharmacology*.

Researchers from The University of Texas Health Science Center at Houston and Ohio University examined the impact of various forms of carbon nanoparticles in a laboratory experiment on human platelets – blood's principal clotting element – and in a model of carotid artery thrombosis, or blockage, using anesthetized rats.

"We found that some carbon nanoparticles activate human platelets and stimulate them to aggregate, or clump together. We also demonstrate that the same nanoparticles stimulated blockage of the carotid artery in the rat model," said research team leader Marek Radomski, M.D., Ph.D., of the Center for Vascular Biology at the Brown Foundation Institute of Molecular Medicine (IMM) at the UT Health Science Center.

C60, a spherical carbon molecule also known as a fullerene or "bucky ball," was the exception, showing no effect on human platelet aggregation and very little effect on rat thrombosis.

"This research is not a case against nanotechnology. It's difficult to overestimate the importance of this amazing technology's ability to transform medicine. But it's good to assess the risk of a new technology in advance. This is a case for moving ahead in a cautious and informed

way," said Radomski, who also is a professor of integrative biology and pharmacology at the UT Medical School at Houston.

Nanoparticles – so tiny that they are measured in billionths of a meter – pass easily through the lungs and into the bloodstream, Radomski said, where they can interact with platelets. They also tend to aggregate on their own, a property that could also enhance blood clotting.

"Medical evidence has been accumulating mainly from epidemiological studies that exposure of humans to particulate matter, and to very small particles, increases the risk of cardiovascular disease," Radomski said. "The mechanisms of that risk are not well-known. Clot formation is my research interest, and we wanted to look at the effect of nanoparticles – both the pollutants caused by combustion, and engineered nanoparticles that might be used in various nanomedical devices such as improved drug delivery systems."

In a paper posted online last month ahead of publication, the team compared the impact of standard urban particulate matter, mixed carbon nanoparticles, "bucky balls," single-wall carbon nanotubes, and multiple wall carbon nanotubes on human platelet clumping and thrombosis in rats.

In both experiments, the mixed carbon nanoparticles had the most impact, provoking the greatest degree of platelet aggregation and the most dramatic reduction of carotid blood flow in the rats. The single-wall carbon nanotubes ranked second, the multiple wall nanotubes third and the standard urban particulate matter fourth in both experiments.

These four types of nanoparticles also were shown to activate a receptor on platelets that is vital to their aggregation – the glycoprotein integrin receptor. This seems to be the underlying mechanism for the nanoparticle's effects, the researchers note, but each nanoparticle

employed a different molecular pathway to activate the receptor.

Bucky balls had virtually no effect. Nanotubes appear to mimic molecular bridges involved in platelet interactions while the bucky balls do not. This gives the spherical, less adhesive bucky balls a potential advantage in the design of nanopharmaceutical devices for targeted drug delivery or imaging systems, the researchers note.

The impact of mixed carbon nanotubes and standard urban particulates suggests a risk of thrombosis from airborne pollution, in addition to the risk of atherosclerosis and heart attack.

First author of the paper is Anna Radomski, M.D., research associate at the IMM. Other UT Health Science Center co-authors include Paul Jurasz, Ph.D., and David Alonso-Escolano, Ph.D., both post-doctoral fellows at the IMM, and Maria Morandi, Ph.D., assistant professor of environmental and occupational health at the UT School of Public Health at Houston.

Co-authors from Ohio University are Tadeusz Malinski, Ph.D., Marvin & Ann Dilley White Professor of Nanomedicine, and Magdalena Drews, M.D., post-doctoral fellow at the Department of Biochemistry. Radomski and Malinski are longstanding research collaborators and Malinski developed the rat model of thrombosis employed in the study.

Source: University of Texas Health Science Center at Houston