New electrically-conductive polymer nanoparticles can generate heat to kill colorectal cancer cells

November 20 2012

Researchers at Wake Forest Baptist Medical Center have modified electrically-conductive polymers, commonly used in solar energy applications, to develop revolutionary polymer nanoparticles (PNs) for a medical application. When the nanoparticles are exposed to infrared light, they generate heat that can be used to kill colorectal cancer cells.

The study was directed by Assistant Professor of Plastic and Reconstructive Surgery, Nicole H. Levi-Polyachenko, Ph.D., and done in collaboration with colleagues at the Center for Nanotechnology and Molecular Materials at Wake Forest University. This study was recently published online, ahead of print, in the journal, *Macromolecular Bioscience*.

Levi-Polyachenko and her team discovered a novel formulation that gives the polymers two important capabilities for medical applications: the polymers can be made into nanoparticles that are easily dispersed in water and generate a lot of heat when exposed to infrared light.

Results of this study showed that when colorectal cancer cells incubated with the PNs were exposed to five minutes of infrared light, the treatment killed up to 95 percent of cells. "The results of this study demonstrate how new medical advancements are being developed from materials science research," said Levi-Polyachenko.

The team made polymer nanoparticles and showed that they could undergo repeated cycles of heating and cooling without affecting their heating ability. This offers advantages over metal nanoparticles, which can melt during photothermal treatments, leading to a loss of heating efficiency. This also allows for subsequent treatments to target cells that are resistant to heat-induced killing.

A challenge with other electrically-conductive polymers that have recently been explored for photothermal therapy is that these other polymers absorb across a wide range of infrared light. Christopher M. MacNeill, Ph.D., post-doctoral researcher at Wake Forest and first author on the paper, noted that, "we have specifically used electrically-conductive polymers designed to absorb a very narrow region of infrared light, and have also developed small, 50-65nm, polymer nanoparticles in order to optimize both biological transport as well as heat transfer." For example, 50nm is about 2000 times smaller than a human hair.

In addition, the new PNs are organic and did not show any evidence of toxicity, alleviating concerns about the effect of nanoparticles that may potentially linger in the body.

"There is a lot more research that needs to be done so that these new nanoparticles can be used safely in patients," Levi-Polyachenko cautioned, "but the field of electrically-conductive polymers is broad and offers many opportunities to develop safe, organic nanoparticles for generating heat locally in a tissue. We are very enthusiastic about future medical applications using these new nanoparticles, including an alternative approach for treating colorectal cancer."

More information: DOI: 10.1002/mabi.201200241

Provided by Wake Forest University Baptist Medical Center