# New nanotech invention improves effectiveness of the 'penicillin of cancer'

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(Phys.org) —Scientists at the U.S. Department of Energy's Argonne National Laboratory have added a new weapon to oncologists' arsenal of anti-cancer therapies.

By combining magnetic nanoparticles with one of the most common and effective chemotherapy drugs, Argonne researchers have created a way to deliver anti-cancer drugs directly into the nucleus of cancer cells.

Researchers at Argonne's Center for Nanoscale Materials and oncologists at the University of Chicago created nano-sized bubbles, or "micelles," that contained two ingredients at their centers: magnetic nanoparticles of iron oxide and cisplatin, a conventional chemotherapy drug also known as "the penicillin of cancer."

Cisplatin works by directly blocking DNA replication within the cancer cell. However, in order to work, the cisplatin has to make it from the bloodstream through the somewhat rigid barrier of the cell membrane.

"When someone is given a dose of chemotherapy, typically much of the drug doesn't actually make it into the cancer cells. In addition, some cancer patients are sensitive to this drug due to impaired kidney function," said oncologist Ezra Cohen, an author of the study. "This new method gives a way of delivering the dose of therapeutic cargo much more directly, which will enable us to have the same overall effect with a lower total dose, reducing the unpleasant and dangerous side effects of chemotherapy."

"This technique could potentially allow us to increase the proportion of cisplatin in cancer cells by a hundredfold, making it that much more effective a chemotherapeutic agent," he added.

Like the membranes of cancer cells themselves, the micelles are made up of a polymer material whose outer surfaces are hydrophilic, which means they are attracted to water, while the inner parts are hydrophobic, repelling water. "In addition, the surface of micelles can be equipped with targeting molecules capable of recognizing malignancy," said Argonne nanoscientist Elena Rozhkova, lead author of the study.

Rozhkova and her colleagues still needed a way to get the cisplatin into the nucleus of the cancer cell after the micelle had attached to it. To do so, they also encapsulated iron oxide nanoparticles within the micelle along with the cisplatin. These nanoparticles served as tiny "heaters" that were turned on by an applied magnetic field, which caused the micelle container to collapse and release the cisplatin.

This was not the first time scientists had used applied nanomagnetic heat sources as a way to attack cancer cells, but the more targeted approach of the micelles allowed the researchers to use a much lower amount of heat and much less magnetic material, thereby risking less damage to healthy cells.

In order to see the action of the nanoparticles and cisplatin as the micelle collapsed, the researchers used the Hard X-Ray Nanoprobe at Argonne's Advanced Photon Source. "Normally, it's difficult to see how cisplatin is delivered into organelles like the nucleus, but with this technology we can see simultaneously how the drug delivery happens, how the nanoparticles interact with the cell's membrane and the cell's response," said Argonne nanoscientist Volker Rose.

The study, entitled "Efficient cisplatin pro-drug delivery visualized with sub-100 nm resolution: interfacing engineered thermosensitive magnetomicelles with a living system," appeared online in the June 6 issue of *Advanced Materials Interfaces*.

Provided by Argonne National Laboratory

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