Researchers combine three technologies to fight metastatic cancer with light

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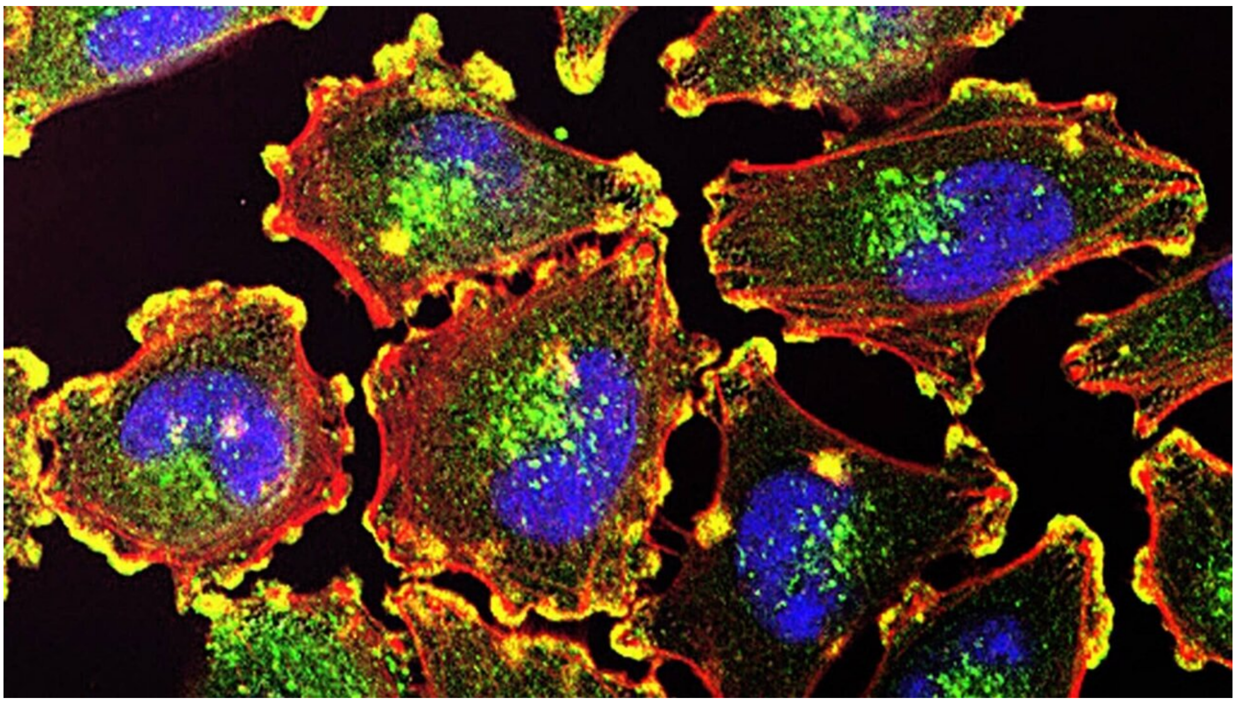

UMD researchers have successfully combined three photoimmunotherapy technologies to help prevent the spread and return of metastatic cancer, while minimizing side effects of treatment. Credit: National Institutes of Health

A team of University of Maryland researchers has made new strides in the fight against metastatic cancer by successfully combining three cutting-edge photoimmunotherapy technologies to help prevent the spread and return of the disease, while minimizing illness and other familiar side effects of treatment.

The study, published in *Science Advances*, is a collaboration between the University of Maryland and Modulight, a designer and manufacturer of lasers for medical application.

Using mouse models, the team studied advanced forms of the deadly disease, which in humans has an average five-year survival rate of less than 30%—a statistic that has not changed significantly in the past 30 years. Many patients relapse due to residual cancer lesions smaller than a millimeter that remain after initial treatments. These difficult-to-detect "micrometastases" often develop resistance to standard treatments, and are the root cause of metastatic cancer.

A rising method of treatment, photoimmunotherapy, targets cancer cells with microscopic, nano-engineered cancer drugs that are activated at the site of lesions using laser light. But because of widely varying responses to the treatment from person to person, the treatment often relies on trial-and-error drug delivery; moreover, no method has existed to readily monitor whether the drugs were delivered effectively or had the desired therapeutic effect.

As the UMD-Modulight study demonstrates, a combination of targeted "photo(nano)medicine" drug delivery, imaging and monitoring of treatment responses could give doctors the ability to make immediate adjustments in treatment, ultimately achieving better outcomes.

"Patients undergoing cancer treatment exhibit varying tolerances and individualized responses. Through continuous monitoring of their progress, we can promptly determine if treatment adjustments are needed while they are actively receiving care," said study leader Huang Chiao Huang, associate professor in the Fischell Department of Bioengineering. "There is no need to postpone decisions until the next scheduled session."

The approach relies on the combination of three advanced technologies to improve treatment outcomes:

- A specialized drug delivery system designed by the UMD research team involves tiny lipid-based containers, or liposomes, loaded with chemotherapy drugs containing fluorescent markers that allow researchers and doctors to track the liposomes as they move through the body to precisely target cancer cells.

- A high-tech, laser-assisted camera created by Modulight uploads information to the company's servers to analyze in real time the different colors of light emitted by the drug delivery system inside the body.

- Information gathered by the camera allows "fluorescence-guided intervention," in which doctors determine in the moment how well the drug carriers are reaching and delivering their cargo to metastatic cancer sites, as well as calculate the precise amount of laser light needed during photoimmunotherapy, minimizing tissue damage.

"This approach ensures that the treatment remains both effective and uniform," said Huang, who leads the Optical Therapeutics & Nanotechnology Laboratory. "This process is repeated as necessary for each patient, resulting in a personalized dosage tailored to maximize treatment effectiveness within a single session."

When these three technologies are combined and applied in mouse models with peritoneal carcinomatosis—a type of cancer that can be caused by spreading ovarian cancer—the research team observed remarkable improvements. For instance, the system developed by the team, known as Targeted Photo-Activable Multi-Agent Liposome, boosts drug delivery to metastatic tumors by an impressive 14 times.

The research team is now working to establish a comprehensive panel of biomarkers that would allow doctors to promptly determine the optimal dosage for each patient during a treatment session.

"The goal is to minimize the number of treatment cycles required while minimizing burden on the patient's body, in contrast to conventional treatment approaches," Huang said.

More information: Barry J. Liang et al, Fluorescence-guided photoimmunotherapy using targeted nanotechnology and ML7710 to manage peritoneal carcinomatosis, *Science Advances* (2023). DOI: 10.1126/sciadv.adi3441

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