Nanotechnology may find disease before it starts

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Nanotechnology may one day help physicians detect the very earliest stages of serious diseases like cancer, a new study suggests. It would do so by improving the quality of images produced by one of the most common diagnostic tools used in doctors' offices – the ultrasound machine.

In laboratory experiments on mice, scientists found that nano-sized particles injected into the animals improved the resulting images. This study is one of the first reports showing that ultrasound can detect these tiny particles when they are inside the body, said Thomas Rosol, a study co-author and dean of the college of veterinary medicine at Ohio State University.

"Given their tiny size, nobody thought it would be possible for ultrasound to detect nanoparticles," he said.

It turns out that not only can ultrasound waves sense nanoparticles, but the particles can brighten the resulting image. One day, those bright spots may indicate that a few cells in the area may be on the verge of mutating and growing out of control.

"The long-term goal is to use this technology to improve our ability to identify very early cancers and other diseases," said Jun Liu, a study co-author and an assistant professor of biomedical engineering at Ohio State University. "We ultimately want to identify disease at its cellular level, at its very earliest stage."

The study is in the current issue of the journal *Physics in Medicine and Biology*.

The researchers injected a solution of silica nanoparticles into the tail vein of each mouse. They then anesthetized the animals and placed them on their backs on a warm imaging table.

Rosol said that Liu and her team are working on creating biodegradable nanoparticles. For the purposes of this study, however, the researchers wanted to use a hard substance, silica, to see if their idea would work. The strongest ultrasound signals are those produced by sound waves bounce off a hard surface. While not biodegradable, the nanoparticles used in the study were biologically inert.

The researchers took ultrasound images of the animals' livers every five minutes for 90 minutes after the injection. The nanoparticles had accumulated in the animals' livers. Another future step for this work is to label nanoparticles with a molecular road map of sorts, which would direct the particles to go to specific locations in the body.

"The liver takes up foreign substances in the body, so it's not surprising that that's where we saw the particles," Rosol said. "But we ultimately want to be able to make these particles to go to the mammary glands or other tissues we're interested in."

The ultrasound images grew brighter over the 90-minute period. The researchers compared these images to those from a group of control mice injected with a saline solution. There was no change in ultrasound image brightness in the control mice after that injection.

While this research is still in its infancy, Rosol and his colleagues foresee a day when nanotechnology can alert a physician to the beginnings of cancer or heart disease, perhaps in a woman who has a family history of

breast cancer:

"Her doctor could inject the breast with nanoparticles and the resulting ultrasound image would alert the doctor to any suspicious areas in the tissue, even at the cellular level," Rosol said.

The hope is that combining ultrasound and nanotechnology may provide a definitive diagnosis in lieu of an invasive procedure like a biopsy.

"These nanoparticles may make it possible for physicians to screen for tumors very quickly, and perhaps lessen the need for a biopsy in many cases," Liu said.

Nanoparticles are smaller than any cell in the human body, so they may pass through the walls of the leaky blood vessels, or capillaries, of tumor tissue and actually infiltrate the tumor.

"Until now, nobody knew what these particles would do in the blood," Rosol said. "But they made it into the liver.

And despite their miniscule size, nanoparticles are still big enough to carry a payload of medicine, Rosol said.

"That the particles made it into the liver suggests that they could be used to deliver toxic chemotherapeutic drugs that would act locally on a tissue, at the site of a tumor, and not have such a pronounced affect on the rest of the body," Rosol said. "The problem with chemotherapy is that the drug affects the whole body, causing a host of problems such as hair loss, diarrhea and anemia."

Source: Ohio State University