Researchers explore nanotechnology as diagnostic and treatment tool

August 14 2006

Nanotechnology is revolutionizing the way things are constructed -- from stain resistant clothing to stronger, yet lighter tennis rackets. However, the biggest impact of nanotechnology in the future is expected to be in the healthcare industry.

At Rush University Medical Center in Chicago, researchers believe nanotechnology can lead to strikingly new ways to diagnosis and treat ovarian cancer. In a unique collaboration with Argonne National Laboratory and the Illinois Institute of Technology, Rush researchers are employing state-of-the-art nanotechnology to improve the health of women.

"While the mortality rates of many cancers have decreased significantly in recent decades, the rate for ovarian cancer had not changed much in the last 50 years, primarily due to delays in diagnosis," said Dr. Jacob Rotmensch, section director of gynecologic oncology at Rush. "By exploiting the unique properties of nanotechnology, we hope to detect ovarian cancer earlier using highly sensitive imaging tools and develop drug carriers that can deliver therapeutic agents inside tumor cells."

"A nanotechnology based approach is needed because diagnosis of early stage cancer requires the detection and characterization of very small quantities of biomarker," added Dr. Liaohai Chen, a molecular biologist and leader of the nano-bio group in the Biosciences Division at Argonne, and an adjunct faculty at Rush University Medical Center.

A nanometer is one billionth of a meter or 1/80,000 the width of a human hair. Nanoscale devices can perform tasks inside the body that would otherwise not be possible, such as entering most cells and moving through the walls of blood vessels. As a result, nanoscale devices can readily interact with individual molecules on both the cell surface and within the cell, in ways that do not alter the behavior of those molecules.

One area of research involves developing a screening test that would not require removal of the ovary for biopsy. Collaborating with Dr. Rong Wang, an associate professor at Illinois Institute of Technology, the research team is using an atomic force microscope, a very-high resolution microscope that can investigate the interaction of individual protein molecules. With this microscope the research team can study the molecular structure of cancer versus non-cancer cells and compare the stiffness. Cancer tissues are more stiff than healthy tissues. Instead of removing the ovary to determine if cancerous tissue is present, a probe is currently under development to follow the tissue stiffness in vivo to diagnose cancer.

A second area of research involving nanotechnology uses viral particles as templates to fabricate uniform, nanometer imaging probes and drug carriers. The research team is extracting the DNA from viral particles and replacing it with imaging agents. The goal is to have the viral capsule adhere to a cancer cell and inject the imaging or a therapeutic agent into the cell. This technology could lead to early diagnosis and the development of targeted drug therapy that kills cancer cells while leaving the rest of the body unharmed.

"The development of a smart probe and carrier complex will provide significant advantage to the clinicians as they can locate the tumor, monitor the drug delivery vehicle and control drug release using imaging techniques," said Chen.

Another avenue of nanotechnology research at Rush is to develop nanometer sized contrast agents with ultrasound to diagnose ovarian cancer. Such nano ultrasonographic contrast media can pass through the smallest capillaries. These tiny bubbles light up on ultrasound and may be able to show the earliest vascular changes associated with ovarian malignancy. If this is successful, further research will be conducted to study targeted imaging as well as targeted therapy.

Ovarian cancer is the fifth-most common cancer among American women and claims the lives of more North American women each year than all other gynecologic malignancies combined. About 75 percent of patients are not diagnosed until the disease is in its later stages, and current therapies are not effective enough to successfully treat the disease in such advanced stages.

"There has been a great amount of progress made in the field of nanotechnology over the last five years, but it has not yet been applied to women's health," said Rotmensch. "We believe this 'small-particle' technology has the capability to quickly and sensitively detect cancer molecules earlier than ever before. This research opens new avenues that will directly impact patient care, such as drug development, diagnostic imaging and ultimately, prevention."

Source: Rush University Medical Center