INSIGHT

TAPPING INNOVATIVE SOLUTIONS & TECHNOLOGY AT JOHNS HOPKINS MEDICINE

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Microgrippers Could Change the Way We Biopsy

Doctors and engineers from Johns Hopkins have developed a mechanical technology aimed at producing better data from biopsies. Rather than a few single-needle samples, the new approach gathers hundreds—even thousands—of tiny tissue samples from many sites.

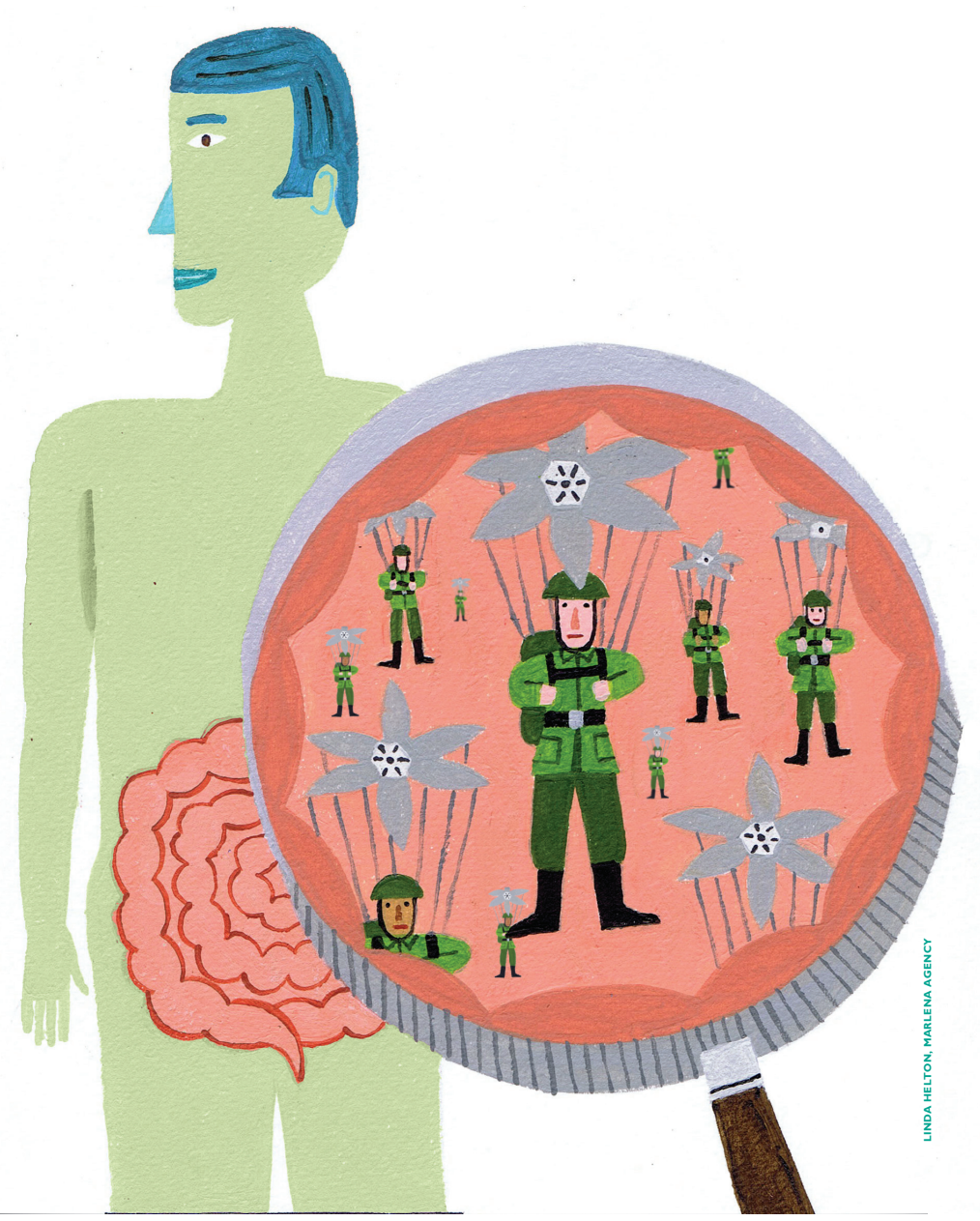
Armies of dust-size, star-shaped metallic "microgrippers" are set loose via an endoscope and spread uniformly into a hollow organ, such as the colon or esophagus, or even hard-to-reach areas like the bile duct. After a few minutes, when the heat-sensitive microgrippers reach a certain temperature, they drift to the walls of the organ and snap shut, each securing a small tissue sample containing valuable diagnostic information. The endoscopist then uses a magnet to collect the microgrippers, still clinging to their payloads.

Florin Selaru of the Division of Gastroentrology and Hepatology and David Gracias of the Whiting School of Engineering have collaborated on the microgrippers, which were the focus of a recent National Institutes of Health research grant. Selaru, Gracias and their teams are refining the microgrippers and performing the final studies the Food and Drug Administration requires before beginning clinical trials.

In the search for cancer, physicians rely on biopsies for two factors: random tissue samples and the ability to visually spot abnormalities. But when diseased tissue is overlooked in random samples or when lesions are too small to see, dangerous cancers can go undetected. Microgrippers offer tissue samples from many more spots and provide a more comprehensive picture of an organ's cells and genes.

Selaru says the cell-based info the tissue samples yield will be important. But he's especially enthusiastic about the ability to better identify more of the early genetic markers of cancer.

"In recent years, we've seen phenomenal genetic and epigenetic information advances regarding human disease in particular cancers," he says. "We envision that the statistical sampling performed with the microgrippers, coupled with biologic analyses of various RNA and DNA markers, will revolutionize diagnostics in medicine."



LINDA HELTON, MARLENA AGENCY

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Software to Assess Heart Function Could Save Billions

Albert Lardo is developing a technology that could eliminate more than 1 million unneeded cardiac catheterizations in the U.S. each year.

The gold standard for assessing coronary artery disease—the leading cause of death in the United States—involves placing a thin tube into the heart to examine blood flow. Each year, over 1 million patients have this procedure, called catheterization, when they don't really need it because the diagnostic imaging shows unreliable information.

Lardo, a professor in the Heart and Vascular Institute and the Department of Biomedical Engineering, along with Rajat Mittal, a mechanical engineering professor, patented a technology in 2014 to accurately and noninvasively predict, in minutes, who needs a catheterization and who does not.

The technology combines an algorithm, or formula calculated by a computer, and a CT scan. After injecting the patient with a contrast agent, the clinician performs a CT scan to see how the contrast agent disperses. The software then examines the 3-D CT scan and creates an information-rich map of the blood flow and pressure throughout the coronary vessels.

"No other noninvasive imaging modality can provide this type of information," says Lardo. "It's a unique intersection where medicine meets engineering to create a solution for a large unmet need. This is precisely the information that the physician needs."

Initial validation studies of the technology are complete, and the next step will be human validation testing to assist in gaining approval from the Food and Drug Administration.

OLD TECH $10 billion — Cost of CT scans and the resulting unneeded catheterizations

NEW TECH $2 billion — Cost of CT scans and software to eliminate unneeded catheterizations

SAVINGS **$8 billion** — Potential cost difference between existing and new technology

*all cost estimated per year

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Retinal Implant Helps People See Again

In December 2014, eye surgeon Jim Handa performed the first procedure at The Johns Hopkins Hospital to surgically implant a retinal prosthesis, also known as a bionic eye.

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The prosthesis, developed in part using Johns Hopkins research that started more than 20 years ago, was approved by the Food and Drug Administration in 2013 for people with retinitis pigmentosa. Results from clinical trials showed that after surgery and rehabilitation, participants were able to recognize movement, read short words and cross a street.

A genetic disorder of the rods and cones in the retina that slowly causes blindness, the disease affects roughly one in 4,000 Americans. Despite the small number of individuals with the condition, Johns Hopkins' commitment to helping these patients is significant.

Gislin Dagnelie, a vision researcher at the Wilmer Eye Institute, contributed to the development and testing of the retinal prosthesis in the 1990s. Today, Dagnelie is overseeing the rehabilitation of Handa's pioneering patient.

"Right now, it's the only clinical treatment for retinitis pigmentosa," says Dagnelie. "You don't turn the system on and then everything is visible, but after intensive rehabilitation and practice, patients learn to understand what they are seeing."

The retinal prosthesis consists of a grid of electrodes in a flexible frame, a receiving antenna and a tiny case of electronics. A set of eyeglasses is fitted with a small video camera above the bridge to capture the physical environment and sends images to a small processing unit carried in the patient's pocket. Instructions from the processing unit are then sent to an antenna on the eyeglasses. Next, the antenna sends instructions to the implant, emitting small pulses of electricity that convey visual information to the surviving cells in the retina. These cells send signals to the brain, and the patient sees patterns of light.

The prosthesis is now in use at a dozen hospitals in the U.S.

WEB EXTRA
Watch a video about the first bionic eye surgery at Johns Hopkins at hopkinsmedicine.org/insight.

Novel Lab Device Provides Window into Cancer Metastasis

"We'd love to take a microscope, zoom inside a patient with cancer and visualize a tumor, but we can't," says Peter Searson, director of the Institute for NanoBioTechnology. Instead, Searson set out to build a device that could show how cancer spreads.

Metastasis, or the spread of cancer from one place in the body to another, can take place through tissue, lymph nodes and blood vessels. Working with doctoral student Andrew Wong, Searson wanted to see metastasis through blood vessels.

To create the most realistic representation of blood vessels inside the body, Wong engineered an artificial microvessel platform. The platform is a palm-size dish containing a lifelike blood vessel with nutrient-rich fluid running through it and reconstituted tissue around it.

"Nobody has simulated metastatic events before in a device as physiologically accurate as ours," says Wong.

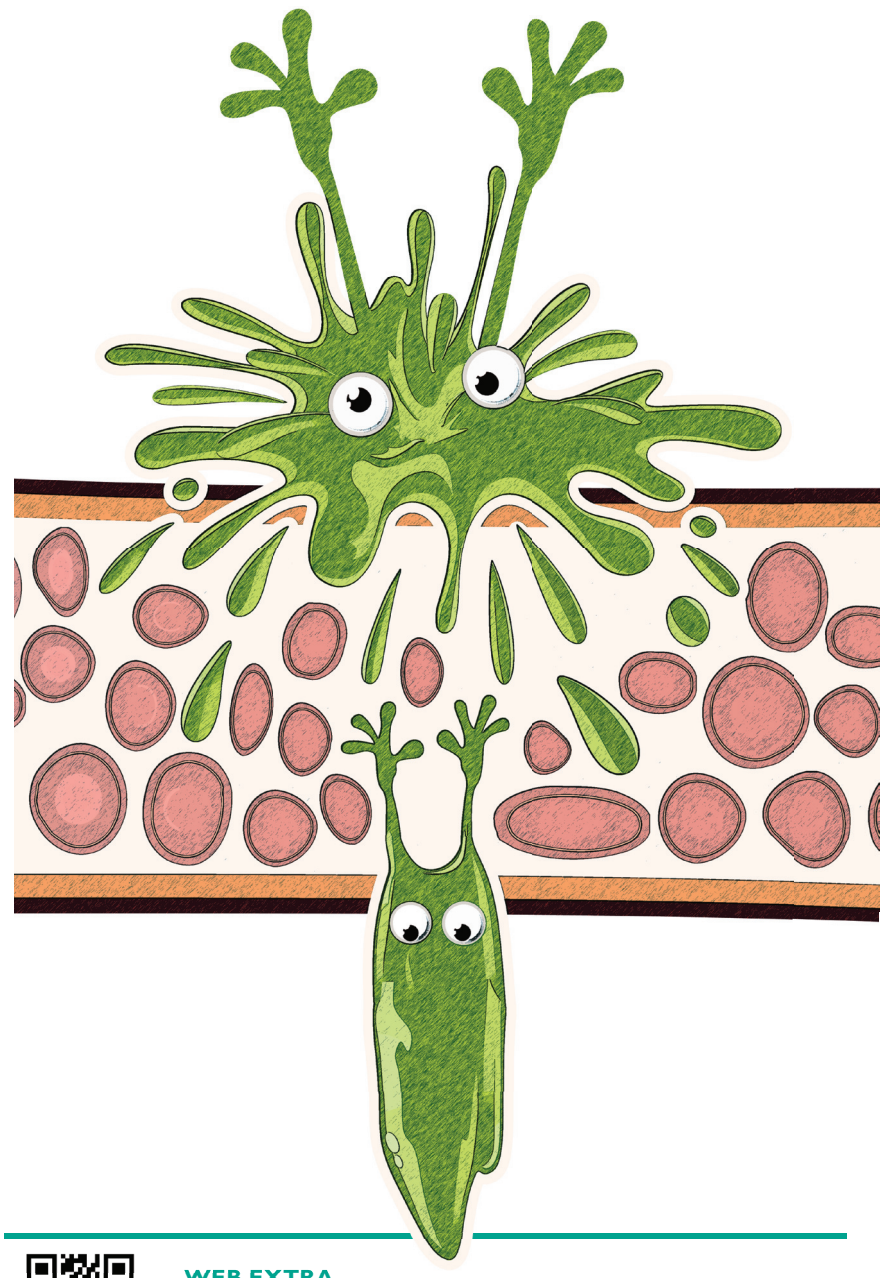
Previous platforms used a single two-dimensional layer of the cells that line blood vessels; others used rectangular channels—nothing like Wong's completely cylindrical vessels with fluid running through them.

After introducing cancer cells near the blood vessel in the device, Wong started filming what was happening through a microscope. "It was like having a window into the body of someone with cancer," says Searson.

Over the course of a few days, Wong and Searson observed how a cancer cell forced its way into the blood vessel and got carried away in the fluid. After that, they saw numerous cancer cells follow the path of the first.

"There can be thousands of circulating tumor cells in a person's body, which suggests there's a bulk entry mechanism into blood vessels," says Wong. "Our device captured this phenomenon."

The researchers aim to use the new device to advance knowledge of cancer metastasis and help test new drugs to prevent it. "We hope to understand how chemotherapeutics can penetrate through our vessels and into tumor cells, and how to best deliver those drugs," says Wong.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WEB EXTRA
To see a video of metastasis in Wong's device, visit hopkinsmedicine.org/insight.

It's Not What You Want, It's What They Want

Each month, nearly 1,000 visitors to hopkinsmedicine.org voluntarily answer survey questions about their expectations of and experience on the website. Their answers provide insights into what is being done well and areas that need improvement.


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Overall, Web content receives extremely positive responses, says Aaron Watkins, director of Internet strategy for the Marketing and Communications Department. "We also see where we have opportunities to expand certain content based on what visitors indicate they expect from John Hopkins Medicine," he says. "For example, visitors often seek extremely detailed disease, diagnosis and treatment information that we do not consistently address. As soon as we learn this, we are able to work with our clinical and research partners to get that information posted."

Recently, one survey response noted the lack of detailed information on neuroscience research projects. This provided valuable input for a project under consideration to build a searchable, topics-based system for all Johns Hopkins Medicine research areas, beginning with neuroscience, says Watkins. A pilot Web presence will launch on hopkinsmedicine.org soon.

Another example of how survey responses have impacted website design is the recent addition of highlighted faculty profiles alongside search results, says Watkins.

The survey is based on the American Customer Satisfaction Index, which has been used to assess customer behaviors and business performance for more than 80 years. It measures perception of and satisfaction with the Johns Hopkins Medicine website experience, and future intentions for the Johns Hopkins Medicine brand, services and products.

Data collected in 2014 show the website has many strengths. "We are performing well above the industry average in health care, which includes health care systems such as Cleveland Clinic and Mayo Clinic," says Watkins. "The highest performing sections of our site include the Health Library, where we are making the greatest investments in our digital strategy. This is also where we can often provide new content, which surveys show our visitors are seeking."

The Health Library offers advice from Johns Hopkins experts on diseases, conditions, tests, procedures, prevention guidelines, and recipes and nutrition information.

For more insights about Johns Hopkins Medicine's Internet strategy, check out the Left Nav blog at bit.ly/leftnav. To learn more about specific aspects of the survey and its findings, reach out to Aaron Watkins.