# INSIGHT

TAPPING INNOVATIVE SOLUTIONS & TECHNOLOGY AT JOHNS HOPKINS MEDICINE

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## MurmurQuiz: Next-Generation Training Game

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It starts with a heartbeat. The first question asks students to distinguish what they hear: Is it normal or abnormal? MurmurQuiz, an online training system, challenges medical students and practitioners to improve the skill of auscultation, or diagnosing heart disease with a stethoscope.

Created by cardiologist Reid Thompson, pediatric cardiology fellow Gary Beasley and the Johns Hopkins Technology Innovation Center, MurmurQuiz presents a picture of a patient's chest and asks the user to decide where to listen, how to use the stethoscope, and whether to listen to the patient sitting, standing or lying down.

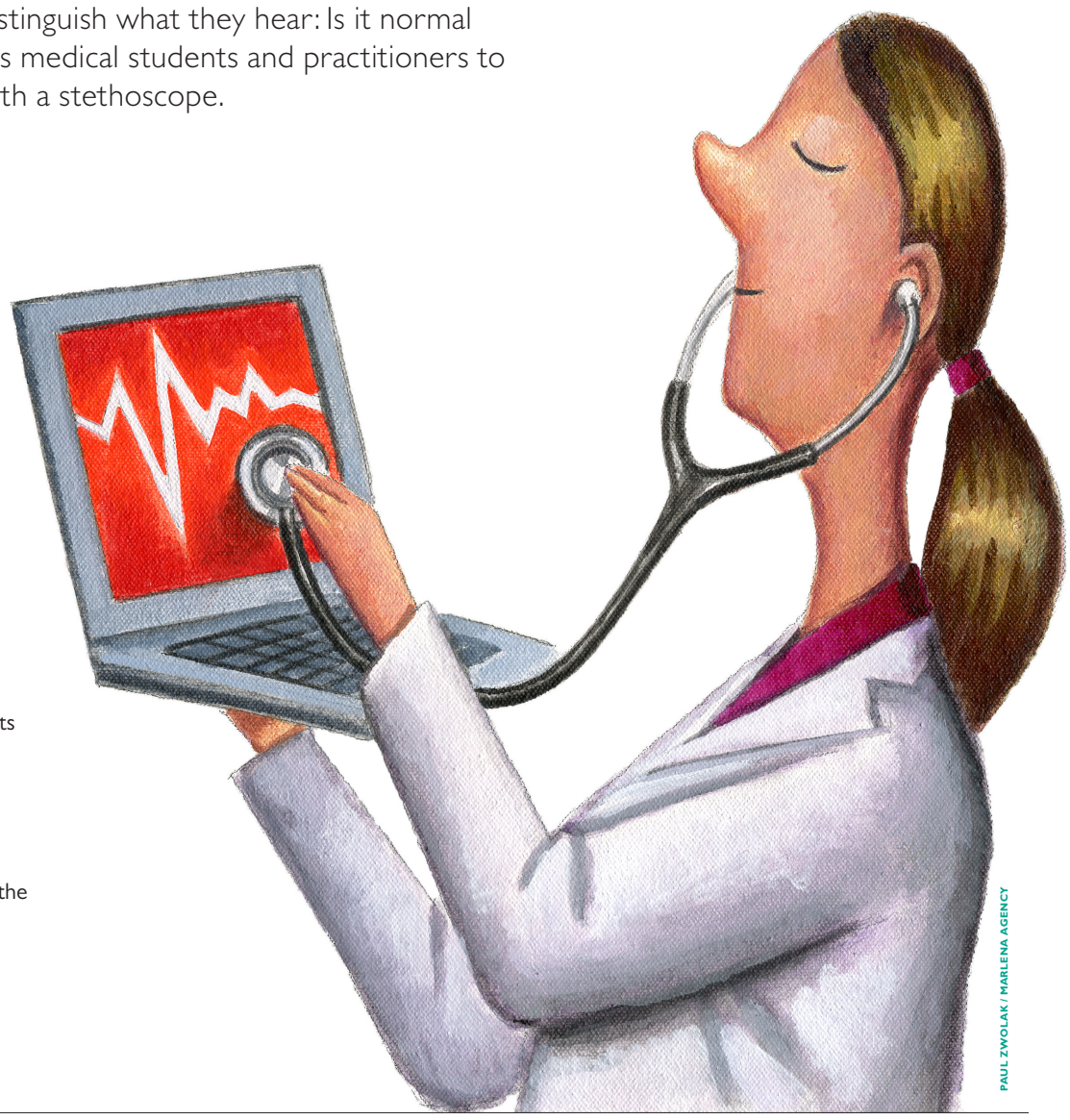
After listening, the student answers multiple-choice questions to pinpoint any abnormalities in the heart sounds and link them to the most likely diagnosis. "You interact as you would in the clinic to formulate a diagnosis," says Beasley.

Thompson began recording heart sounds in 1997 following a period when the use of a stethoscope declined significantly, when ultrasound became the gold-standard method for diagnosing heart conditions. Today, just 20 percent of clinicians are proficient at auscultation.

To help students and clinicians hone their skills, Thompson created a free online virtual cardiac clinic in 1999—MurmurLab (murmurlab.org)—where users could listen to more than 5,000 sounds from over 1,000 patients. MurmurQuiz (mumurquiz.org) is the new iteration of this project, offering an interactive, gamelike experience that saves students' results and tracks their progress.

> "You interact as you would in the clinic to formulate a diagnosis."
>
> –Gary Beasley, *pediatric cardiology fellow*

Eventually, Thompson hopes these efforts will help devise a way to accurately test proficiency of auscultation for board exams. In the meantime, MurmurQuiz is being used by medical students and residents at The Johns Hopkins Hospital and will be available to users outside of the organization later this year.



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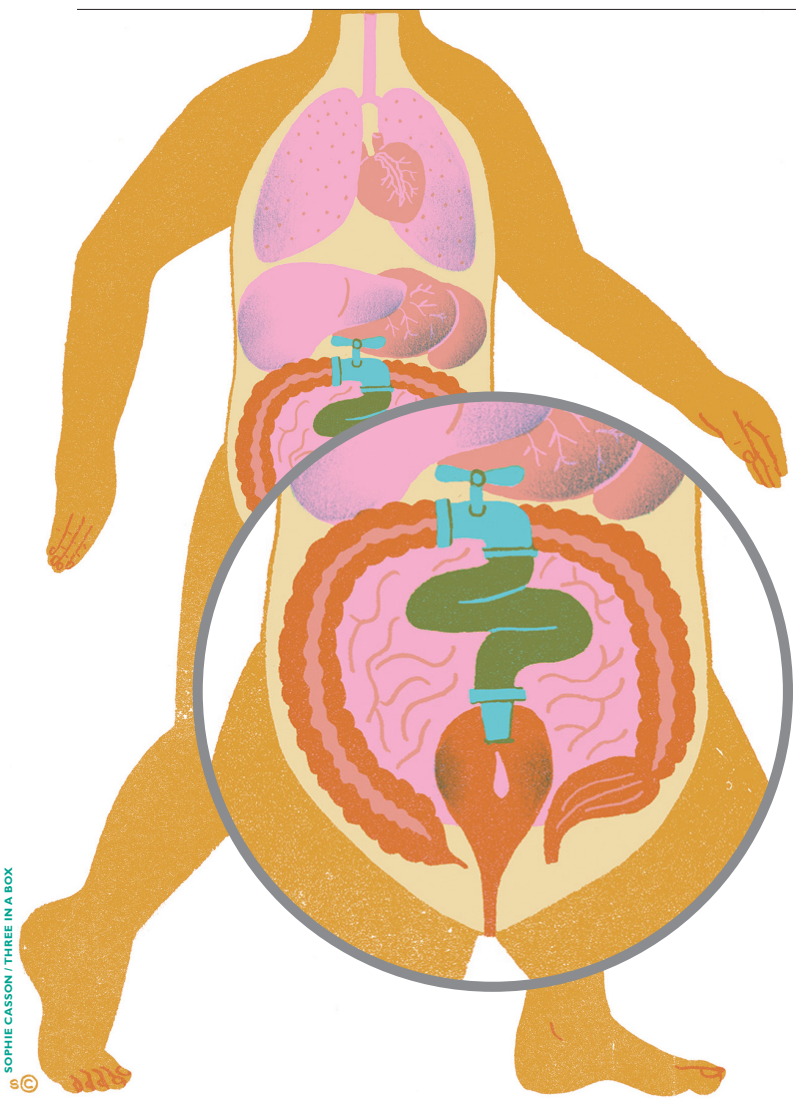


SOPHIE CASSON / THREE IN A BOX

## Mechanical Pump Could Relieve Discomfort in Patients Waiting for Liver Transplants

Ashish Nimgaonkar says his invention will save the U.S. health system millions of dollars. But better than that, he says, it will make life better for many patients as they await liver transplants. Nimgaonkar and his lab team are testing a mechanical pump in animals that uses natural body movement to eliminate fluid buildup in the abdomen.

Patients with decreased liver function often develop a condition called ascites, where fluid collects in the abdomen (peritoneal cavity). Water leaks out of blood vessels and into the area with nowhere to go and no way to move, causing uncomfortable abdominal swelling and distension.

"Until the patient gets a liver transplant, the only way to alleviate the pressure has been to drain the fluid manually every week or two," says Nimgaonkar, a gastroenterologist and medical technology researcher. "That can cost between $2,000 and $3,000, and the fluid buildup significantly impairs the patient's quality of life."

Motion from normal daily activities triggers the pump to send fluid from the abdomen to the bladder. "Body movement creates a pressure differential between the cavity with the fluid in it and the bladder or stomach. The pump senses the difference in pressure and drives the fluid from one chamber to the other."

After the pump moves fluid out of the cavity, patients would eliminate it naturally.

Nimgaonkar is currently testing the surgically implanted pump in animal models and, if all goes well, the innovation will move to clinical trials within a few years. For people with ascites, the pump could be a life-changer. "Best of all," says Nimgaonkar, "these patients don't have to get so sick."

**WEB EXTRA: See a slideshow of pump prototypes at hopkinsmedicine.org/insight.**

A look at innovative developments outside the halls of Johns Hopkins Medicine

## Cancer Treatment Apps

*Hospitals are turning to apps to help patients with breast cancer manage their conditions from home and, in some cases, feed critical information back to physicians. Currently in pilot stages, these apps are being tested in select medical facilities.*

**A pain management app called ePAL allows patients to document side effects from cancer medications.** Patients can also request medication refills and access educational videos and supportive messages from their care team. Developed by Massachusetts General Hospital, the app alerts clinical care staff if a patient's reported pain approaches a crisis level.

**Patients can manage their own diagnosis information and treatment instructions through the Breast Cancer Ally app.** Users receive daily reminders about their prescribed regime, complete with diagrams for post-surgery exercises. Patients can access information about every stage of treatment, from chemotherapy to reconstructive surgery. Developed by the University of Michigan, the app also offers guidance about when to consult a doctor.

**An app developed by QoC Health for the Women's College Hospital in Toronto aims to prevent postoperative complications after discharge from the hospital.** Patients answer questions and take pictures of their incision site, and the app sends doctors a list of patients who are in need of care. Currently in a randomized trial, preliminary results suggest the app helps reduce in-person visits.

# Color-Coded Map to Ensure Cancer Removal

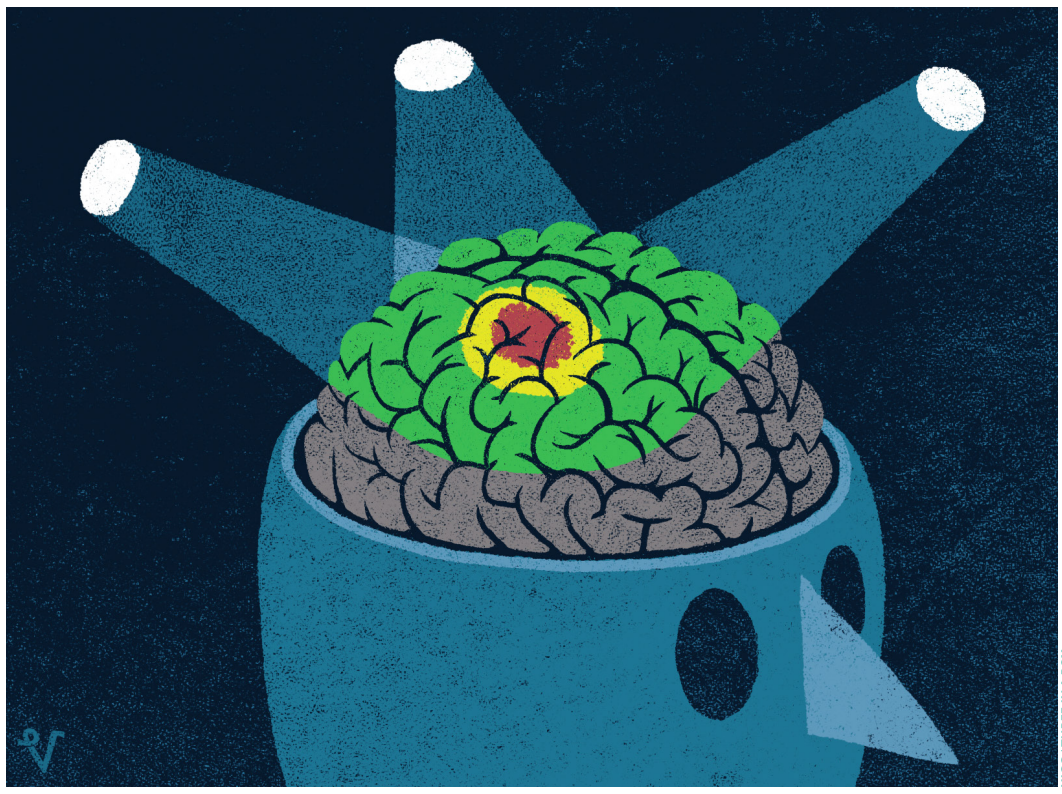
Brain tumor removal surgery is a balancing act: Miss a piece of tumor, and a patient may suffer from shortened survival; take too much, and memories, movement or speech may be compromised. To add to the challenge, brain tumor and normal tissue can look identical during surgery. A new surgical mapping technology, however, could be the answer.

"I have dedicated my life to perfecting the surgical resection of these tumors, and yet when you look at the amount I resect, on average, it's just 70 to 80 percent of the tumor," says neurosurgeon Alfredo Quinones-Hinojosa.

In 2011, Quinones-Hinojosa received an email from M.D./Ph.D. student Carmen Kut. She was working on optical coherence tomography (OCT), which functions like ultrasound but uses light instead of sound waves.

Kut was wondering if Quinones-Hinojosa could help her test OCT to tell the difference between cancer and healthy tissue.

Quinones-Hinojosa's lab started forwarding samples from patients and animals to Kut and her advisor, physicist and biomedical engineer Xingde Li, a pioneer of OCT technologies.



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Kut and Li began imaging the samples, looking for differences in the way light bounced back between brain tumor and other tissue. Li brainstormed with Kut and provided guidance on how to analyze the data and turn the numbers generated by OCT into an innovation for the operating room.

In a few years, they developed a novel algorithm that analyzes the OCT image in real time and provides an intuitive color map that shows cancer in red, noncancerous matter in green and areas where cancer is beginning to infiltrate in yellow.

In November 2015, Kut, Li and Quinones-Hinojosa launched the first clinical study testing the feasibility of the technology in the operating room. The team is also working with several entities to develop a commercial product.

# Command Center to Improve Patient Flow

If you're looking to take the pulse of The Johns Hopkins Hospital, look no further than its new command center—a 2,550-square-foot "inner brain" packed with giant monitors displaying real-time data about everything from bed availability and operating room efficiency to patient status and staffing.

It's all part of a larger project aimed at improving institutional efficiency—one that includes the use of a simulation model of the hospital that draws on historical data to forecast future demand for patient beds.

Previously, staff members relied on time-consuming phone calls, emails and even faxes to communicate bed availability among departments. The new command center will control the flow of patients from the moment they are admitted to their discharge—all from one place.

"What we're trying to do is change the way we manage patient capacity in the institution and perhaps ultimately throughout the health system," says James Scheulen, chief administrative officer for emergency medicine and capacity management for Johns Hopkins Medicine. The project is a collaboration with GE Healthcare Camden Group.

Staff members from bed management, the Hopkins Access Line and admitting sit at rows of workstations inside the command center near the Nelson/Harvey lobby. Analytic tools developed by GE provide real-time information from multiple systems across the hospital for 22 monitors. The data allow the team to make quick, informed decisions on bed assignments or whether a unit needs assistance.

"We don't believe any other hospital is using these integrated tools and command center technology," says Mary Margaret Jacobs, director of patient/family and visitor services for The Johns Hopkins Hospital.

Jacobs says this proactive approach will help ensure the command center's success. "Technology helps, but transforming the culture and aligning operations are going to be critically important," she says.