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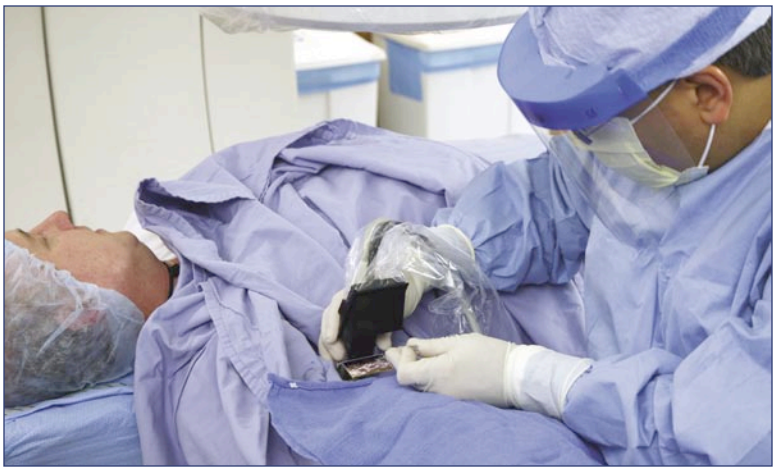
Science *Non*-Fiction

Device Shows Promise for Making Image-Guided Procedures Faster, Safer

It's like something out of a H. G. Wells novel or a Star Trek episode. A device small enough that you can hold it in the palm of your hand, but that has the power to see through flesh. When it comes to science, this is as sexy as it gets.

The device is called the sonic flashlight, which was invented by George Stetten, MD, PhD, associate professor of bioengineering at the University of Pittsburgh and associate research professor at Carnegie Mellon's Robotics Institute. Stetten also has a secondary appointment in Pitt's Department of Radiology—which makes sense, given his collaborations with radiology faculty to test his flashlight device.

Nikhil Amesur, MD, assistant professor of radiology, is Stetten's clinical partner. They recently authored a paper about the utility and promise of the flashlight. The study, published in the December issue of *Radiology*, found that ultrasound-guided vascular access can be learned and performed faster with the sonic flashlight than with conventional ultrasound in vascular phantoms. (Phantoms are models constructed to resemble human tissues and are used for medical research and training).



Nikhil Amesur, MD, assistant professor of radiology, uses the sonic flashlight in the interventional radiology suite.

"Using traditional ultrasound to guide procedures can be time-intensive to learn, because the process isn't natural or intuitive," says Amesur. "It requires you to look at an image on a screen, and guide a needle into a patient while looking away from the patient."

An ultrasound device consists of a probe, which is attached by a cord to a machine—and the screen, which displays the image. The probe is lubricated with a clear jelly and is glided over a patient's skin by the physician or technologist. The probe transmits high-frequency sound waves into the body, and the way in which those sound waves are reflected back to the probe are relayed to the machine, which creates an image of the patient's internal structures.

For ultrasound-guided interventional procedures, Stetten thought that it was an "obvious idea" to create a device that is built around a conventional ultrasound machine, but allows the proceduralist to look directly at the patient's target body part without having to rely on a screen image that is not in the natural line of sight.

"An Obvious Idea"

Stetten conceived of the project back in 1999, when he was sitting in an orientation meeting at Carnegie Mellon, having just landed in Pittsburgh from Duke

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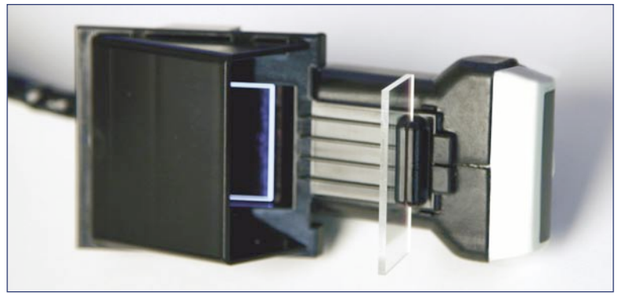
Sonic Flashlight

Shows Promise for Making Image-Guided Procedures Faster, Safer



The sonic flashlight is small and portable, making it feasible for use at a patient's bedside.

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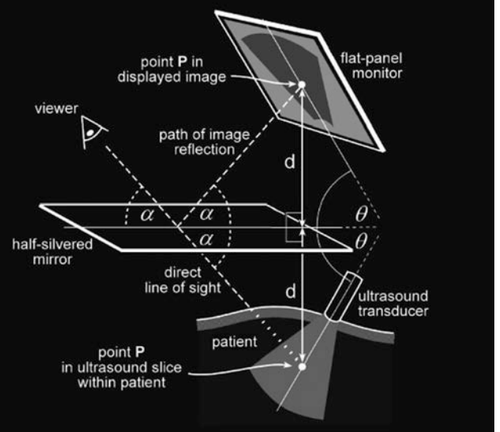
University. He applied for a patent quickly, because he just knew it was "one of those kinds of ideas."

He's been hard at work ever since, aided by Amesur and a stream of ambitious PhD and MD, PhD candidates, many of whom are interested in pursuing radiology residencies. One of those former candidates, Wilson Chang, MD, PhD, the first author on the recent *Radiology* paper, is starting his radiology residency at Stanford in July. Chang's valuable work on the sonic flashlight helped him secure his PhD from Pitt.

How the Sonic Flashlight Works



Stetten is now assisted closely in the lab by David Wang and David Weiser who, during the past three years, have made numerous revisions to the sonic flashlight. Wang is an MD, PhD candidate nearing the end of his PhD training and Weiser is a staff engineer. Gaurav Shukla, the fourth member of the lab and also an MD, PhD candidate, recently joined the team and is expected to assist in further developments of the flashlight.

Currently they are building prototype version eight of the flashlight, continually tweaking the device to make it more relevant and clinically useful.

Out of the Lab, Into the Hospital

Stetten was helped early on by Richard Simmons, MD, the current medical director of UPMC and former chairman of the department of surgery. Simmons thought Stetten should first try to use the flashlight to help guide the placement of peripherally inserted central catheters (PICC), and also suggested Amesur as an energetic physician who might be willing to collaborate with Stetten.

PICCs are placed into the large veins of the arm for administration of medications and chemotherapy drugs. The use of PICC lines for these purposes is increasing astronomically—so if the sonic flashlight can make insertion of these lines faster and easier; it could be an incredibly valuable tool.

Amesur remains the only physician to date that has used the sonic flashlight clinically on patients—he has successfully placed 30 PICC lines in the interventional radiology suite, and has also placed a central line in one patient to date. He feels the preliminary results using the device are "very encouraging."

UPMC's IV team has now been entrusted to use the device after being trained by Amesur. Wang, who runs the clinical trials, expects the IV team to have placed over 40 PICC lines using the flashlight at the bedside by the end of January 2007.

Thomas Killcrece, a veteran technologist in interventional radiology who works closely with Amesur, is optimistic about the potential for the flashlight, and says if he had to insert a PICC line, the flashlight would make him feel far more comfortable with the process.

"What I like about this device is that the physician doesn't have to look away, even for a moment," says Killcrece. "With traditional ultrasound, the doctor may have found the vessel with the probe, but has to break concentration to look up at the screen, and sometimes that small break—that one second—causes them to lose the image they need."

So the flashlight can be useful in cases where the user is inexperienced at image-guided procedures—but is it useful for those experienced users who've already acclimated to the awkward, traditional mode of inserting a needle while looking elsewhere at a screen?

"Yes," says Stetten—and the *Radiology* study backs him up.

"We were curious about that very question," says Stetten, "and we found in this study that nurses at UPMC, who are very experienced, were still able to perform the procedures faster using the sonic flashlight in phantoms."

Shukla, one of Stetten's protégés, boils it down: "So yes, you can teach an old dog new tricks."

Amesur's work is part of the ongoing clinical trials of the sonic flashlight, funded through a two million-dollar NIH grant that he and Stetten worked to secure (they are co-principal investigators). These clinical trials began after the positive initial findings of the *Radiology* study, which deemed the sonic flashlight ready for clinical trials.

In addition to the published *Radiology* paper, Amesur and Stetten have also presented their research on the flashlight at the annual meetings of several major medical societies, including the Radiological Society of North America, the American Roentgen Ray Society and the Society of Cardiovascular and Interventional Radiology.

The current testing of the flashlight is two-fold: PICC lines are being placed in patients at the bedside, carried out by experienced nurses; and the flashlight continues to be used in the interventional radiology suite by Amesur, but for more complicated cases, such as tunneled dialysis catheter placements, which are inserted into the internal jugular (neck) vein. Once this has been accomplished, the next phase will entail allowing the critical care medicine doctors to use this device in the Intensive Care Unit at UPMC Presbyterian.

Line placements in the internal jugular and femoral (thigh) veins are more complicated because these veins are closer to larger arteries and are thus traditionally placed by physicians.

When you view the jugular vein and carotid artery with ultrasound, you see just how close together they are—and can imagine that the wrong one could be punctured quite easily, especially by someone who is inexperienced.

Wang, one of the MD, PhD candidates on Stetten's team who also holds an MS in computer science from Cornell, has created a program that works with ultrasound to clearly identify the vein from the artery—it marks the vein with a blue "plus" sign and the artery with a red "plus" sign. The program analyzes different properties from the ultrasound image to make the determination, and so far has been "working beautifully," according to Stetten. The program can be used as an addendum to the flashlight, or alone with ultrasound.

While some grumble that an experienced interventionalist would know the difference between artery and vein, it may prove helpful for those with less training—a virtual guide to the right location, especially out in the field, such as in a combat zone where time is critical and the user is under pressure.

Future of the Flashlight

In addition to Amesur, other radiologists such as Jules Sumkin, DO, director of women's imaging at UPMC and chief of radiology at Magee-Womens Hospital of UPMC, are interested in working with the flashlight. Stetten and Sumkin have pending grants to conduct breast biopsies guided by the device.

Surgeons are also excited about this technology because it could expand image-guided surgery. Michael Howowitz, MD, associate professor of neurological surgery and radiology, authored a paper with Stetten and Chang that was published in the April 2005 issue of *Neurosurgery*. The paper contends that "the impact of this device on neurosurgical procedures could be significant. The ease of use, intuitive function, and small instrument size allow the surgeon to quickly localize lesions, confirm surgical positioning, and assess postoperative results."

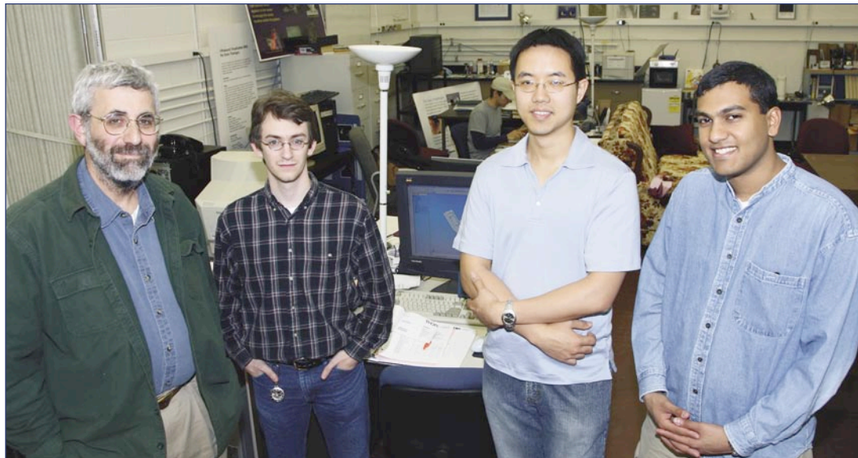
Now that the sonic flashlight has moved into the clinical phase, it will become evident whether the flashlight is just a novel idea, or a truly groundbreaking device. Clearly, those who've worked closely with the flashlight are strongly optimistic.

Many of the initial issues with the device have been resolved—for example, the first prototypes featured glass mirrors that were potentially breakable and therefore could injure a patient, so the team created a model with a plastic mirror so that patient safety isn't compromised.

Stetten and his team have pragmatically addressed issues with the flashlight, one by one. Stetten is an engineer at heart, but you get the sense that he doesn't fit the researcher mold—he wears other hats, including writer and musician. Then you come to find that he arrived at his lab in Benedum Hall in an nontraditional way, having first completed his medical degree before deciding that medicine wasn't for him. He didn't like the breakneck pace, the emotional stress, the lack of time to consider—to work out the best way to do things. He is at home in his lab, where his work allows him that luxury of careful consideration.

Stetten may not practice medicine, but his sonic flashlight could certainly end up altering the practice of medicine for years to come.

-Christy Rippel



(Below), George Stetten, MD, PhD and his team: (L to R) Stetten, David Weiser, David Wang, Guarav Shukla.