Robots from space lead to one-stop breast cancer diagnosis treatment

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This is the IGAR manipulator and full breast intervention platform mounted on the patient support structure with a biopsy tool attached. Credit: CSii and MDA

We may not be driving flying cars to work yet, but that doesn't mean we don't have a lot to be excited about from technology advances related to the space age. Instead of zipping past traffic jams, International Space Station-derived robotic capabilities are giving us a fast pass to life-saving surgical techniques with cancer-fighting finesse.

According to the National Cancer Institute, an estimated 232,340 women and 2,240 men will be diagnosed with breast cancer by the end of 2013 alone. From that, about 39,620 women and 410 men will not survive.

The goal for a team of collaborative researchers with the Centre for Surgical Invention and Innovation (CSii) in Canada is to reduce those numbers significantly. They are scheduled to enter an advanced platform into clinical trials this fall for use in the early diagnosis and treatment of breast cancer.

The main player besides the medical staff is a robot. But not just any robot. This one's technology was designed for use aboard the International Space Station by MacDonald, Dettwiler and Associates Ltd. (MDA) for the Canadian Space Agency (CSA).

Researchers created the Image-Guided Autonomous Robot (IGAR) from a long line of computerized heavy lifters and maintenance performers for the space shuttle and space station: CSA's Canadarm, Canadarm2 and Dextre. In dealing with breast cancer, IGAR is expected to provide increased access, precision and dexterity, resulting in highly accurate and minimally invasive procedures.

"The IGAR platform moves the use of robotics in surgery to a new dimension, allowing the robot to act in an automated fashion after programming by a physician," said Dr. Mehran Anvari, chief executive officer and scientific director at CSii. "This technology has been practiced in manufacturing and in space, but is new to medicine."

IGAR is designed to work in combination with an MRI scanner, which is highly sensitive to early detection of suspicious breast lesions before they possibly turn into a much larger problem. The radiologist uses specially designed software to tag the potential target and tell IGAR what path to take. The software then helps the radiologist to make sure he or

she is accurately hitting the right area. IGAR has a special tool interface that can be used to define adaptors for any needle-based biopsy device or a wide range of instruments that remove body tissue, known in the medical world as needle-based ablation devices.

"Our automated robot is capable of placing the biopsy and ablation tools within 1 mm (about three-tenths of an inch) of the lesion in question with a high degree of targeting accuracy, improving sampling, reducing the morbidity and pain of the procedure, reducing time in the MRI suite and saving significant dollars as a consequence," said Anvari. "It also will allow all radiologists to perform this procedure equally well, regardless of the number of cases per year and move the site of treatment from operation room to radiology suite for a significant number of patients."

The radiologist can operate in the challenging magnetic environment of the MRI, providing access to leading tumor-targeting technology. The robot fits on the patient bed, so it can travel in and out of the MRI opening easily. This in turn simplifies the flow of patients in the department, which can be challenging to many radiologists, optimizing patient time to diagnose.

IGAR removes most of the "manual" aspects of the procedure and reduces user-dependence and the level of training required. This allows for a standard process regardless of experience. An expert will program remotely once the patient is in the MRI suite. A physician will then supervise only to make sure the patient is comfortable and there are no complications, even if he or she has limited knowledge of the procedure.

"I've been teaching MRI-guided breast biopsy for years and there are many steps in the procedure that are operator-dependent," said Dr. Nathalie Duchesne, co-investigator on the clinical study and breast radiologist at the Hospital Saint-Sacrement in Quebec City, Quebec,

Canada. She will be performing the first of three clinical trials. "These steps may prevent good sampling of the lesions if it's not done properly. I believe IGAR will take care of this. It will subsequently decrease the time of the exam, ensure good sampling and increase patient's comfort during the exam. We think that IGAR will improve sample collection because it will be less operator dependent and it will be constant from one doctor to another, from one patient to the other, from one lesion to the other."

"This technology lays the foundation for a family of telerobotic systems," said Anvari. "It has the potential to change the way we think about performing these interventions and ensures that specialized, highly-trained doctors are focusing on the activities to which their training is best suited. We believe this technology will improve efficiency in the health care system by streamlining clinical workflow and allowing highly-skilled radiologists to extend their care to a wider population through teleoperation."

This robotic technology is not limited only to biopsies. "I think IGAR is paving the way for the minimally-invasive excision and treatment of small tumors that are often found incidentally during pre-op MRI," said Duchesne.

The trend toward breast preservation has brought on the importance of lumpectomies. For tumors that may require this procedure because they are invisible to ultrasound and X-ray mammography, researchers are currently developing the ability for IGAR to deploy a radioactive seed—smaller than a grain of rice—near the area of interest. During surgery, the seed can be located with a detector, allowing the doctor to identify the lesion and remove it with increased accuracy and patient comfort. It's expected that follow-up surgeries also will be greatly reduced.

So, from the space station to the ground, robotic arms lend a hand, whether it be to grab an arriving resupply vehicle or to help save more lives.

Sandra Kay Yow, head coach of the North Carolina State Wolfpack women's basketball team from 1975 to 2009 and an advocate of breast cancer awareness, once said before she lost her battle in 2009, "When life kicks you, let it kick you forward." With researchers taking to the International Space Station and then bringing their beneficial technologies back down to help lives on Earth, we are on a journey forward hopefully to one day make cancer history.

Provided by NASA