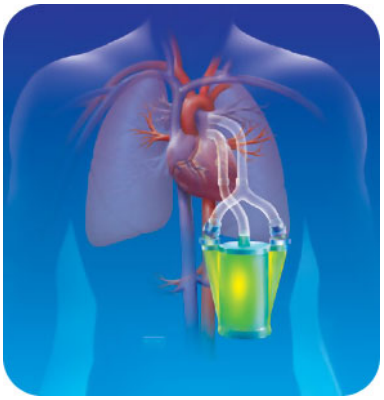
FROM "PRINTING "NEW SKIN TO USING COCKROACH BRAINS TO FIGHT SUPERBUGS, CHECK OUT THE BEST OF AN AMAZING ARRAY OF INTERNATIONAL MEDICAL ADVANCES MADE PUBLIC IN THE PAST 12 MONTHS FROM AROUND THE WORLD

MEDICAL BREAKTHROUGHS 2011

BY CLAUDIA CORNWALL

LUNG TRANSPLANTS

"It was the longest day of our lives,"



Says 32-year-old drama and English teacher Christina Foster, Foster has cystic fibrosis, a genetic disease that causes a host of ailments, but in particular the buildup of thick, sticky mucus in the lungs. Sufferers regularly require lung transplantation as their condition worsens.

That day in the winter of 2009, Foster and her husband waited in the Toronto General Hospital, in Canada, for a verdict that could mean life or death. Since the age of five, Foster had suffered from increasingly serious lung infections that required her to leave her hometown and get treatment in Toronto. But despite her doctors' best efforts, her health continued to deteriorate. Her energy level was so low that she could hardly walk, let alone pick up her infant son. She coughed constantly, despite being hooked up to oxygen, and she was losing weight. "In December 2009," she says, "I was told to think about some new lungs. That was a scary conversation."

Of all the organs that can be transplanted, the lungs are the most perishable. Up until recently, only 15 percent of donated lungs survived ling enough to make it to transplant. With so few lungs available, approximately 20 percent of patients died while waiting for an operation.

Foster was put on a waiting list in April 2010, and moved to Toronto to be closer to the hospital; at 12:30am on August 10 she got a call to say a pair of lungs might be available, and to come to the hospital immediately. With thoughts of an imminent transplant racing through their heads, the couple went right away, and then waited anxiously through the night for word on whether the donated lungs were viable. At 8:30 the next morning, the nurses told her it was yes, and she was wheeled away for the major operation.

While Foster had been waiting, her

Medical team had been using new technology, a breakthrough pioneered by Dr. Shaf Keshavjee, director of the Toronto Lung Transplant Program Internet on saving more lives, Keshavjee had wanted to come up with a system that would allow doctors to assess and repair damaged donor lungs. Under his leadership, a team at Toronto General Hospital, working with a Swedish company called Vitrolife, developed the remarkable Toronto XVIVO Lung Perfusion System.

Historically, organs are cooled after harvesting, but with the XVIVO system, the lungs are placed in a protective transparent chamber and maintained at normal body temperature (37o C). Kept warm and pumped with a healing fluid containing oxygen, nutrients and proteins, they can stay alive outside the body much longer than before: up to 12 hours. This gives surgeons time to assess and repair any damaged. With the XVIVO system, more than 30 percent of donated lungs are viable – double the number before the use of this technology. In addition, because patients now receive predictably healthier lungs, they do better and recover faster from the operation.

In 2008, Keshavjee became the first surgeon in the world to successfully transplant an XVIVO-repaired lung. Now, use of the technology is spreading. “The XVIVO concept will have a significant impact on the field,” says Keshavjee. “It changes the paradigm of all organ transplantation.” The idea is not just to transplant organs, but to transplant improved ones.

The day after her operation, Foster

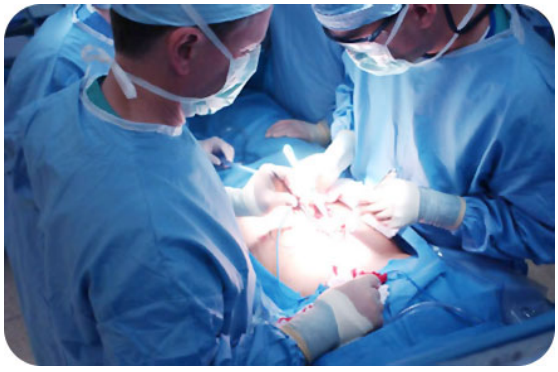
Awoke at 11:00am to find herself on a respirator. But by that afternoon, she and her “new” reconditioned lungs were doing so well that she began to breathe on her own. Two days later, she was up and walking; nine days after the operation, she left the hospital. “It’s a miracle,” she says. “I just can’t believe this is possible—that I have someone else’s lungs. It’s just such an amazing thing.”

And further advances are coming. In October 2009 Keshavjee and his team published a study in Science Translational Medicine showing that the XVIVO system could deliver gene therapy to lungs and reduce the need for immunosuppressant drugs. The next step is a clinical trial.

STATUS: *Genetically modified lungs are not yet available to the public, but reconditioned lungs are.*

SURGERY

Surgical sponges are the most common objects mistakenly left inside a patient after surgery. A study of more than 190,000 patients, conducted from 2003 to 2006, found that one in 5500 patients suffered through this painful and life-threatening experience. But now there is a reliable way to prevent such a mistake and make surgeries for patients.



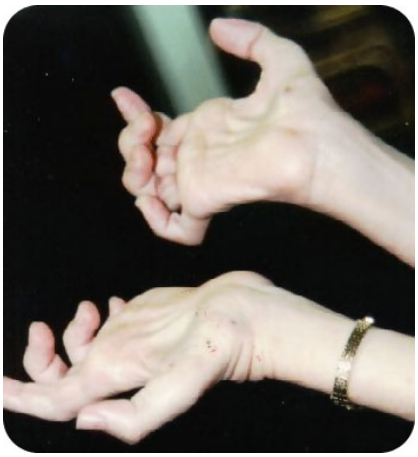
In February 2010 the Pennsylvania based company Clear Count medical Solutions received [US] Food and Drug Administration (FDA) approval for its radio frequency identification (RFID) tags. Sewn into surgical sponges and gauze pads, these tags are similar to the ones used to

track merchandise in department store. Medical personnel scan each tagged sponge as it is used, then again as it is removed don't match, a nurse can find the missing item—whether it is in the patient, hidden in the bed lines or dropped on the floor—with an electric wand.

***STATUS**: Already approved by the FDA and being used in some hospitals in the USA.*

DIAGNOSTICS

Until recently, finding and diagnosing rare genetic diseases in patients took months, or even years. But in 2009 a team of researchers at the University of Washington discovered how to speed up the process. Instead of looking through the sum total of a patient's genetic material (the genome), the team suggested examining just the exome—the portion of the genome containing our 20,000 to 25,000 protein—coding genes, or about two percent of the whole. Researchers suspected that most disease—causing errors could be found there, and proved their theory by locating in the exome the gene for a rare disease called Miller syndrome. (The results of the study were published in Nature Genetics in November 2009.)

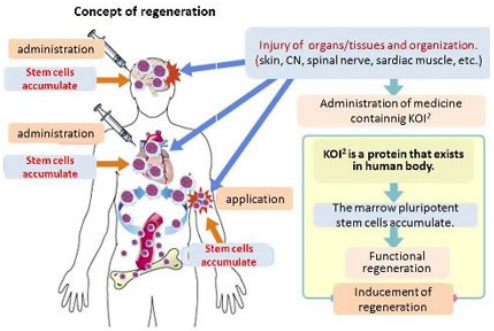


The reduced search area means scientists will be able to find other rare genetic mutations much more quickly and cheaply than in the past.

STATUS: Exome sequencing is available to the public now, through the McGill university health Centre in Montreal.

REGENERATION

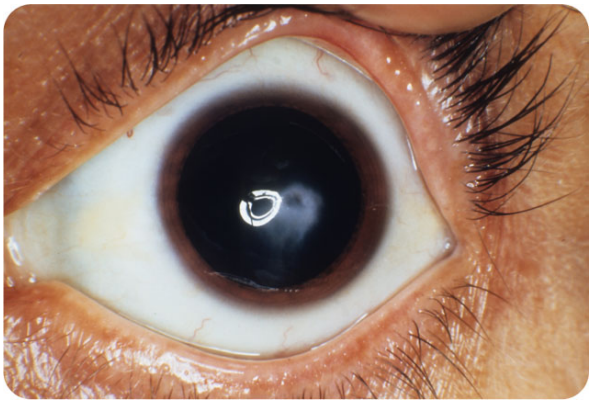
Imagine using some of the same technology used by a common house hold desktop printer to print new skin cells, which could help heal burns. A team at the Wake Forest Institute for Regenerative Medicine in Winston Salem, North Carolina, USA, has used a "bio-printer" to do just that. The device contains a laser that scans a patient's wound to measure its dimensions. Then a computer controls the release of skin cells, which are sprayed directly onto the wound, precisely where they are needed.



The bio-printer has only been tested on mice so far, but results show burn wounds healing two weeks faster than normal. Bio-printing would replace skin grafting, a painful procedure in which skin is taken from one part of the body to cover another. With a bio-printer, subjects' own skin cells can be grown and multiplied in a lab to refill the printer. "You could cover the whole body after eight weeks of growing cells," says Dr Anthony Atala, director of the Institute for Regenerative medicine.

***STATUS:** Human trials in about three to five years.*

SIGHT



Corneal scarring or clouding is a major cause of blindness around the world, and in many countries a short age of donated corneas means that people have to wait two to three years for a transplant that will

help them see. Wanting to address this problem, May Griffith, who holds appointments at the Linkoping University in Sweden, the Ottawa Hospital Research Institute and the University of Ottawa, decide to try to make an artificial cornea.

After ten years of work, she and her team finally succeeded. " We took a synthetic collagen produced by yeast cells, then chemically treated and moulded it so that it is the shape and size of the natural human cornea," explains Griffith. To the body, this collagen appears quite natural. "We managed to get back into this material, resulting in a 'regenerated' cornea that resembled normal, healthy tissue."

In a clinical trial recently conducted at Linkoping University, of the ten patients who received the implants, six showed improved vision. With the use of rigid contact lenses, on average all patients can now see as well as patients who had conventional corneal replacements.

STATUS: *Still in clinical trials.*

THE FIGHT AGAINST CANCER

When Maphors Weatherly, a 79-year-old retired chief master sergeant of the US Air Force, began spitting up blood on December 21, 2009, he knew it wasn't a good sign. But he never suspected cancer. His only other symptom up until that point was fatigue. "I had attributed that to the aging process," He says.

After paying a visit to the Brooke Army Medical Center near his home in universal City, Texas, Weatherly found out he had a cancerous tumour in his right lung. "It was larger than a man's fist," he says. The news got worse: the tumour was advanced between Stage 3 and Stage 4 inoperable.

Weatherly decided to go to the Cancer Therapy & Research Center, at the University of Texas Health Science Center in San Antonio, to explore his treatment options.

There, he heard about a clinical trial being conducted by Dr Alain Mita, an oncologist. It involved combining standard chemotherapy with Reolysin, a formulation that contains a live, naturally occurring human virus called a "reovirus."

"Normal cells can get rid of the reovirus very quickly," explains Mita, "but some cancer cells have a problem eliminating the virus. That's why eventually the reovirus will kill them."

Developed by Canada-based Oncolytics Biotech Inc, Reolysin is currently being evaluated in clinical trials for a variety of cancer types. Mita is the first physician to use it on squamous-cell lung cancer. According to him, patients such as Weatherly live, on average, no longer than a year. "It makes sense to try new treatments to improve this extremely poor outcome. We haven't made much progress in this particular type of cancer in the last 20 years." Mita's current trial involves 18 to 20 patients, and, if the results are good, he will proceed to a larger trial of 50 patients.

In Weatherly's case, the results of the new treatment have been exceptional. After six months of chemotherapy and Reolysin, his tumour shrank by 90 percent. "It was half the size of a man's thumb," says Weatherly, "and the growths that had spread into my chest were almost gone."

Now, Weatherly is off the chemotherapy and on a maintenance dose of Reolysin. It causes mild aches and fever, but his energy is returning. "I feel well. I have no pain and I am breathing easily."

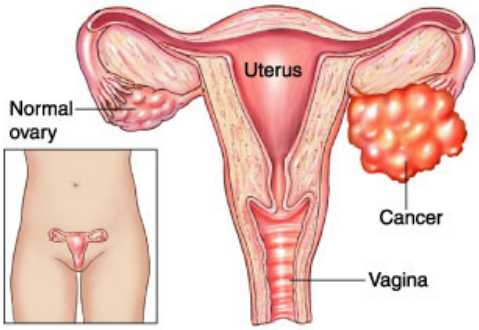
Reolysin trials are ongoing elsewhere.

In the UK, a small trial involving five patients with serious head and neck cancers, presumed to be terminally ill, has yielded dramatic recovery results in three patients. A second, larger trial has shown encouraging results, and a Phase 3 trial of almost 200 patients is now underway.

All of this is delightful news for Matt Coffey, a former postgraduate student at the University of Calgary, Canada, and now the chief operating officer of Oncolytics Biotech. Coffey has been studying the reovirus since the 1990s and was instrumental in making the discovery that it kills cancer cells in animals. "Being involved in the discovery and then being able to put into a Phase 3 trial is quite a rarity."

STATUS: *Still in clinical trials.*

OVARIAN CANCER



Researchers at the BC Cancer Agency in Canada recently made a discovery that could reduce deaths from ovarian cancer by as much as 30 percent. Dr Sarah Finlayson, a gynecological oncologist with the agency's Ovarian Cancer Research Program, found that the deadliest from of ovarian cancer originates in the Fallopian tubes, not the ovaries.

As a result of this finding, the BC Cancer Agency is calling for a change in surgical practice. When an older woman undergoes a hysterectomy, she typically has her Fallopian tubes and ovaries removed along with her uterus. But when younger, premenopausal women undergo hysterectomies, usually their Fallopian tubes and ovaries are not taken out. "That's a surgical convention," says Finlayson, who would like surgeons to remove the Fallopian tubes, no matter what the patient's age. "If your uterus is coming out, you don't need your Fallopian tubes. They don't have a hormonal function."

LEARNING FROM ANIMALS, PART I, COCKROACHES (SUPERBUGS)

Could cockroaches save your life one day? Yes, according to a team of researchers at the University of Nottingham in the UK. Powerful antibiotic properties in the brains of cockroaches and locusts are able to kill more than 90 percent of bacteria—intruders that are often deadly to humans, including methicillin-resistant Staphylococcus aureus (MRSA) and pathogenic Escherichia coli—without harming human cells.

These findings, which were presented at the September 2010 meeting of the Society for General Microbiology in Nottingham, could lead to novel treatments for multi-drug-resistant bacterial infections.

STATUS: *Available to the public in five to ten years.*

She would also like gynecologists to consider a change in their methods when they are doing tubal ligations: “If a woman is requesting permanent contraception, a clip is placed on the Fallopian tubes, or the Fallopian tubes are burned, but left inside. If those Fallopian tubes are no longer required, we would like gynecologists to consider removing them as opposed to just clipping or burning them.”

According to Finlayson, whose research was published in the International Journal of Gynecological Cancer in 2009, this change alone could significantly reduce ovarian cancer kills tens of thousands of women the world over.

STATUS: *The Ovarian Cancer Research Program is working with other organizations to spread this new information.*

STEM-CELL RESEARCH

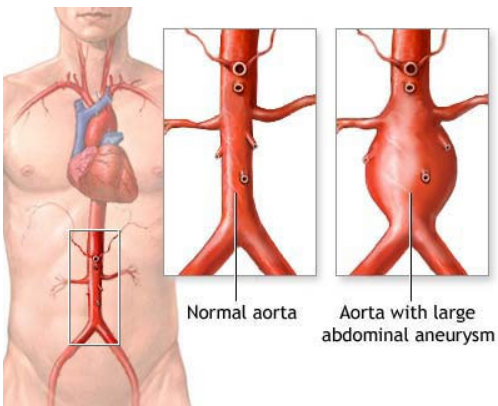
Can stem cells improve heart function? Teams from the Research Centre; of the University of Montreal Hospital Centre and from the Maison-neuve-Rosemont Hospital are collaborating on two studies to find out. In one study, led by Dr Samer Man sour, a cardiologist at the University of Montreal Hospital Centre, 40 heart attack patients are getting their own bone-marrow stem cells fed into their damaged heart muscles through their arteries. The trial is ongoing, but results seem promising. “Patients are recovering better than you would normally anticipate,” says Dr Denis Claude Roy, co-investigator of the study. “This is most encouraging.”

The second trial, led by Dr Nicolas Noiseux, is focusing on improving outcomes for coronary-bypass patients who have previously had heart attacks. The procedure involves injecting their own stem cells directly onto their heart muscles. “We measure the function of the heart by something called the ‘ejection fraction’ –the capacity of the heart to pump blood everywhere in the body,” explains Man sour, co-investigator of the study “If your heart is receiving 100cc of blood, an ejection fraction of 60 percent is normal. The patients we treat have an ejection fraction of about 40 percent or less. Our first patient improved by 15 percent. Which is very impressive.”

STATUS: *Still in clinical trials.*

HEARTS

Troy Golden is a 45-years-old nurse and church minister from Geary, Oklahoma, USA. He suffers



LEARNING FROM ANIMALS, PART II, THE SHREW (OVARIAN CANCER)

A few years ago, jack Stewart, a bio-chemist at mount Allison University in Sackville, Canada, became curious about shrew saliva. One of the few venomous mammals in the world, the northern short-tailed shrew uses its poisonous spit to paralyze its prey grubs, baby mice and birds.

After isolating a tiny amount of an active compound in this saliva—a protein called “soricidin”—Stewart discovered something unexpected: The compound kills ovarian-cancer cells. Better yet, it leaves normal tissue alone.

In June 2010 Canada’s National Research Council invested over $500,000 in Soricimed Biopharma Inc, the company that Stewart helped start.

STATUS: *All set for Phase 1 trials of soricidin ovarian-cancer therapy.*

from a genetic co nnective-tissue disorder known as Mar fan syndrome, which has been slowly but surely destroying his heart. In 2000 Golden underwent his first valve replacement, and he had another series of repairs sox years later. But his heart kept racing.

"It was like he was running a marathon all the time without being able to stop," says his wife, Darla. "He was constantly exhausted. You could see his heart pounding when he was sitting still."

Even an implanted defibrillator couldn't keep up. Designed to detect and correct abnormal heartbeats, implanted defibrillators send mild to strong shocks to the heart in order to return fast rhythms to normal. On Cristmas Eve 2009, golden's implanted defibrillator delivered an especially strong jolt, and over the next several days, it delivered at least 30 more. "It's a lot of voltage going through your body. It's extremely painful," says Darla.

By the time Golden was taken to hospital on December 30, his heart had basically given out. He needed a transplant and was put on a waiting list. In the United States alone, some 3000 people wait for heart transplants every year, but only 2000 donor hearts are available. The demand for hearts is greater than the supply, and patients often wait months for a match.

For Golden, the odds were lower than normal. His O-positive blood type and six-foot-three frame significantly reduced his likelihood of finding a match quickly. But his doctors had an interim solution for while he waited: an artificial heart.

Used in several European countries

As well as Australia, the United States and Canada, the SynCardia temporary Total Artificial Heart is not a new device, but its manufacture has recently given it a new twist.

Normally, patients who receive temporary artificial hearts are confined to hospital for months—and sometimes years—tethered to a 190-kilo machine while they await a transplant. But last year, in a US first, Arizona-based SynCardia Systems Inc began a clinical study to test a portable option for powering the artificial heart. Called the "Freedom" driver, this six-kilo toaster-size device is designed to allow patients to enjoy a relatively normal life at home while they wait for their transplants. According to Don Isaacs, a vice president at SynCardia, once 60 patients complete the current study, the FDA will determine whether or not to approve the Freedom driver for general use. The cost of the heart and driver is about $125,000.

Troy Golden received a Total Artificial heart Integris Baptist Medical Center in Oklahoma City on September 15, 2010. A month later, he was discharged and sent home. His Freedom driver runs on electricity; he can plug it into a wall or rely on its batteries. When he's in his car, the device runs with a charger, just like his cell phone. Golden is delighted just like be home with his family and his two beloved dogs, Samson and Delilah.

"I'm definitely feeling better than I did before the procedure," he says. "I'm able to walk now. It's very exciting, what's happened."

STATUS: *An FDA decision is anticipated this year, pending results of the current trial.*