Cleveland Clinic

Top 10

Medical Innovations for 2009

Cleveland Clinic

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Top 10

The Cleveland Clinic Top 10

Welcome to the third edition of our Top 10 Medical Innovations. We are pleased to share with you the final results of a rigorous selection process that started many months ago when we asked scores of our clinicians and researchers at the Cleveland Clinic the simple question: "What game-changing medical technology, device, or therapy do you see breaking through in 2009?"

Cleveland Clinic's culture of innovation naturally fosters a good deal of discussion about "hot" new technologies and which ones will have the greatest impact each year. The purpose of our annual "Top 10 Medical Innovations" is to share the perspective of our leaders on what innovations they felt would help to re-shape health care in the next year. As you turn the pages and move from innovation #10, through to the #1 selection for 2009, we are certain that you will be amazed by the diversity of these innovations, their unique utility, and by their truly game changing nature.

Using state-of-the art technology and evaluating next-generation products has long characterized Cleveland Clinic physicians. Questions about which will have the greatest impact on patients have been asked of Cleveland Clinic doctors ever since George Crile, M.D., one of our founders, wrote about the "invisible coin of infinite satisfaction" after he realized that one of his patients was restored to health through one of his inventions. And we continue to ask these questions each year.

AlixPartners assisted us in conducting the detailed selection process. AlixPartners is an international performance improvement, turnaround, and financial advisory firm, with a core of senior consultants who specialize in medical devices, retail, consumer goods, and the automotive industry.

A formal process was used to gather the opinions of Cleveland Clinic physicians and researchers, create a field of nominated innovative technologies for consideration, and develop a consensus perspective of what will be the Top 10 technologies for 2009.

Step No. 1 was to define the universe of potential candidates, and we established that:

- ✔ Nominated innovations could be from any medical field.
- ✔ Nominated innovations could derive from any health care organization.

Four major criteria were the basis for qualifying and selecting innovations. To receive consideration, a nominated innovation was required to:

- ✔ Have significant potential for short-term clinical impact (either a major improvement in patient benefit or an improved function that enhances healthcare delivery).
- ✔ Have a high probability of success.
- ✔ Be on the market or close to being introduced.
- ✔ Have sufficient data available to support its nomination.

We probed the opinions of a broad cross-section of Cleveland Clinic staff from every major medical field as well as operational leaders. In all, these nearly 60 interviews yielded close to 100 nominations of emerging technologies.

These nominated innovations were screened to confirm threshold criteria. AlixPartners assembled background information on each remaining technology, and then presented a final list of more than 30 technologies to two independent panels of leading Cleveland Clinic physicians. In late summer, the panels debated and voted on their Top 10 and then participated in a combined process to select the final 2009 Top Ten Medical Innovations.

The Top 10 represents an unbiased list of important emerging technologies, based on the collective viewpoint of dozens of leading Cleveland Clinic physicians and researchers. We hope you will find our selections interesting and will use them to stimulate your own thinking on future new trends and technologies and maybe even spur some innovation on your own.

The 2009 Top 10 process was chaired by Michael Roizen, M.D., Chief Wellness Officer, Cleveland Clinic. Dr. Roizen, a former editor for six medical journals, has published more than 160 peer-reviewed scientific papers, 100 textbook chapters, 30 editorials, and four medical books. His first general audience book, "RealAge: Are You As Young As You Can Be?" (HarperCollins) became a #1 New York Times best-seller. He has authored a number of other books, including several New York Times bestsellers.

The Mind Of The Inventor

Creativity is thinking up new things.
Innovation is doing new things.
- Theodore Levitt

From what source does medical innovation spring? How do breakthrough ideas and innovations get nourished and eventually brought to market when there are so many barriers to be hurdled?

As you will see with our Top 10 selections for 2009, innovations flow from many sources and their ultimate success depends on a variety of factors, including a relentless desire of the inventor to do something useful; an ability to think beyond conventional paradigms; a willingness to constantly ask questions; and a fearlessness in taking risks. A certain level of technical skill and know-how are also indispensable.

In addition, it helps to be optimistic. Most, if not all of the innovators involved with this year's Top 10, certainly know about dogged determination, long hours, and an ability to cast away self-doubt and find rays of sunshine on the especially gloomy days. These are all important characteristics of the inventor.

Necessity is the mother of invention.
- Plato

New inventions happen all the time, but necessity certainly plays a major role. According to the results of a recent survey, more than 20% of American inventors believe that their most creative thoughts come while traveling in a car. Some inventions come during a brainstorm by a creative thinker out on a 50-mile bike ride. Others occur while stooped over a patient in the OR, an array of medical tools near, when suddenly it becomes obvious that the task being performed or a particular tool being used now seems obsolete. New possibilities are conjured up. Can I come up with an innovative solution that can make this procedure work better? Can I create a wholly new product, a practical tool that medical personnel will want to use?

Chance favors the prepared mind.
- Louis Pasteur

The Cleveland Clinic received more than 100 nominations for this edition of the Top 10. As in the past, our panel of judges looked for innovations that broke new ground in their fields and demonstrated measurable impact. The Top 10 for 2009 consists of innovations from inventors working today. They have been chosen because these medical products are necessary and ahead of their time. They also help solve problems and fill critical needs.

The circulating cancer cell test for metastatic cancer is the #1 innovation in the Cleveland Clinic's third annual competition. The second place winner was the warm organ perfusion device for transporting donated hearts; while the phrenic nerve stimulator to enable paralyzed patients to breathe without assistance of a mechanical ventilator was the third place awardee.

To the inventors behind all nominated innovations, and to all the inventors linked with the Top 10 Innovations for 2009, your work is vital and we thank you for your discoveries.

10 Private Sector National Health Information Exchange

Use of a common exchange standard among participants to enable access through the Internet regardless of provider source.

Modern medicine has robots that assist with urological procedures and 320-slice CT scans to peer into the heart, and by the time you reach a certain age, terabytes of your personal health-care information are already stored on the servers of hospitals, insurance companies, and pharmacies throughout the country.

Then in this age of Internet health information searches, online banking and shopping, why is it that when you walk into a doctor's office, you are handed a clipboard and asked to fill out paper forms that ask about your medical history? Why is medical record keeping in the United States still back in the early 20th century?

Things are starting to change, albeit slowly. A comprehensive system of electronic health records that link consumers, general practitioners, specialists, hospitals, pharmacies, nursing homes, and insurance companies is in the process of being established. Primarily a private-sector effort, this computerized system has the potential to replace paper-based medical files with digitized records of patients' complete medical history.

Many patient records are now buried in paper files in doctors' offices. But imagine being able to find, access, and store your personal medical records as easily as you access your e-mail, anywhere and anytime. Potential advantages of personal health records are many: A lifetime view of your history will allow doctors to focus on preventive strategies, rather than just treating disease.

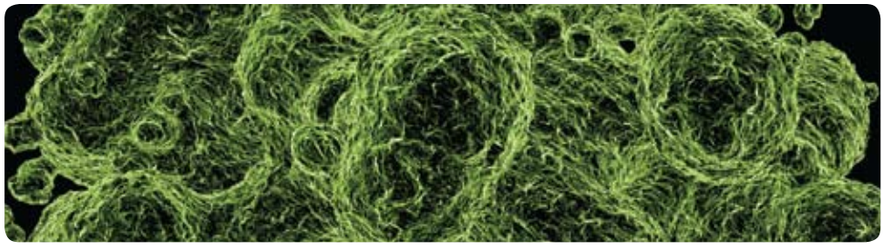
In addition, skyrocketing health care costs, now approaching $2 trillion annually, will be significantly reduced for employers, insurance companies, and the government just through the elimination of administrative overhead. Moreover, many of the 98,000 deaths that occur annually from medical mistakes and adverse drug reactions can be avoided once the full patient records of patients became easily accessible for all treating doctors.

Over the course of the past decade, the Internet has helped transform life in America, changing the way we get our daily news, and how we work, bank, shop, and travel. The good news is that many companies are now developing promising systems for storing digital health records that will allow people to electronically collect, view, manage, and share copies of their health information.

"We think the ideal model is the consumer-driven approach, where the consumer is in control of what information is gathered and stored at a central repository and who they choose to share it with," says Joe Turk, Director of Information Technology at the Cleveland Clinic. "Personal health records will certainly be revolutionary in health care management, helping to reduce errors, improve health, and save money."

9 Doppler-Guided Uterine Artery Occlusion

Doppler-guided non-invasive transvaginal uterine artery occlusion for treatment of symptomatic uterine fibroids.



Fibroid tumors occur in upwards of 40% of women older than 35, triggering pelvic pain, pregnancy complications, and heavy bleeding. One third of the 600,000 hysterectomies performed each year in the United States are for uterine fibroids, non-cancerous abnormal growths of fat in the wall of the uterus that can grow to the size of a cantaloupe. While this disease has such a major impact on the lives of millions of women, it is rarely discussed because it's not cancer.

Women with fibroids often bleed excessively during their periods and can become anemic. In addition to urinary frequency, because of pressure on the bladder, and excessive back pain, many women have significant discomfort and take pain medication during their periods. Fibroids can reduce fertility—especially when they are located in the uterine cavity—and often trigger a variety of obstetric complications, including premature birth.

Over the last decade, several procedures have been introduced to help women avoid major surgery for this condition, but hysterectomy remains the most common treatment for fibroids. However, it is a major surgery and does not preserve the uterus.

There is a new, non-invasive approach to treat fibroids called Doppler-guided uterine artery occlusion, or DUAO, that could prove to be attractive to many women and their physicians. This experimental procedure is currently undergoing pivotal clinical trials at centers throughout North America and Europe.

"This procedure offers great promise," says Marie Paraiso, M.D., Co-Director of the Program for Female Pelvic Medicine and Reconstructive Surgery at the Cleveland Clinic. "It has the potential to offer women who have failed medical therapy a non-invasive procedure that's an alternative to hysterectomy, surgical removal of uterine fibroids, and uterine fibroid embolization."

Here is how DUAO works: After being given an epidural injection in a hospital outpatient setting to provide patient comfort and minimize lower limb movement during treatment, a special clamp is placed through the vagina by the gynecological surgeon. With the assist from Doppler-guidance provided by crystals located at the tips of the clamp, the surgeon locates the two uterine arteries by the special sound waves and occludes the arteries. This generally takes only 15 minutes to accomplish.

This simple mechanical compression is temporary and after six hours, the clamp is removed, restoring blood flow to the uterus. However, during the period that the clamp is in place, the fibroids are starved of oxygen and nutrients, and start to die. The uterus, however, can sustain itself during the temporary artery occlusion. Eventually the excess fibroid tissue will slough off and get reabsorbed by the body, resulting in a significant decrease in fibroid-related size and symptoms.

8 Integration of Diffusion Tensor Imaging (Tractography)

Integration of diffusion tensor imaging (tractography) with surgical navigation of the brain to minimize damage to fiber tracts during brain surgery.

If you wanted to know how the halogen headlights in your automobile worked but only looked at the switch on the dashboard, and ignored all the wiring that goes from the switch to the battery and lights, you'd never understand the system. In a way, that's how it used to be in the study of the brain before the recent introduction of diffusion tensor imaging (DTI) unveiled the all-important fiber pathways that connected the hundreds of billions of neurons in the brain.

DTI is the new technology that allows neuroscientists to non-invasively probe the long-neglected half of the brain called white matter, with its densely packed collection of intertwining insulated projections of neurons that join all four of the brain's lobes, allowing them to communicate with each other. Previously, permanent damage could often occur to white matter during brain surgery, because technologies were not available to give neurosurgeons an accurate roadmap of white matter pathways.

With DTI, however, neuroscientists can locate the orientation of nerve fiber bundles. This all-important information is now used in surgical planning and prognosis, allowing experts to accurately map the living brain noninvasively. The results are presented in stunning two-and

three-dimensional color images, which are available at the time of surgery. The images can be integrated with the three-dimensional localization system to precisely localize pathways with the exact part of the brain viewed by the surgeon.

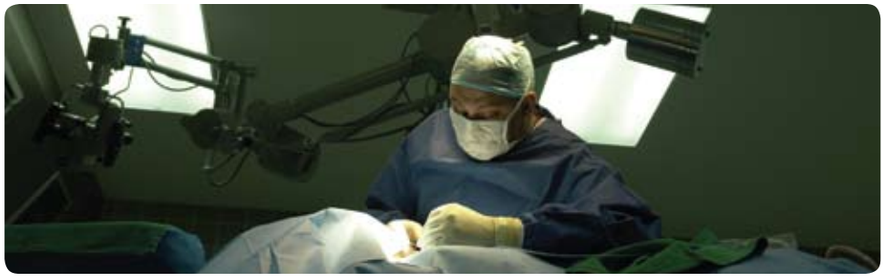
"White matter comprises almost half of the brain, providing the connectivity and allowing the brain to perform its many mental operations," says Micheal D. Phillips, M.D., a neuroradiologist at the Imaging Institute at the Cleveland Clinic. "Until we had diffusion tensor imaging, which measures the movement of water in the brain to infer the location of white matter fibers that link brain regions, we had no imaging method to accurately localize connecting pathways. DTI is helping us create the detailed spatial wiring map of the brain."

Using diffusion tensor technology, for example, doctors can look at the specific pathway that connects brain regions responsible for understanding speech with the brain region responsible for producing speech. Water diffusion in the region of the pathway is greatest parallel to the pathway fibers. Using this knowledge, doctors can map out the pathway called the arcuate fasciculus, which is critical for normal conversational speech. Importantly, knowing the exact position of this pathway would allow a surgeon to avoid injuring the pathway during surgery.

"When it comes to neuroimaging, DTI is the game-changing technology for how we now understand and map the brain," says Dr. Phillips. "We haven't seen anything like this since the introduction of MRI in the 1980s."

7 LESS and NOTES Applications

Laparoendoscopic single-site surgery (LESS) and Natural Orifice Transluminal Endoscopy (NOTES) for nephrectomy, cystectomy, prostatectomy, colon resection, and other applications.



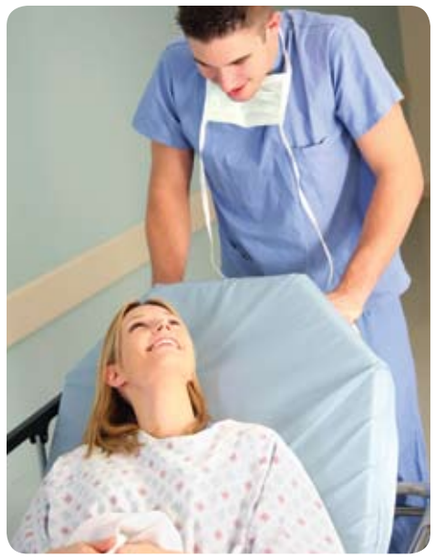
Minimally-invasive laparoscopic surgical approaches have been tried over the years in an effort to improve a variety of standard urological and gynecological surgeries. We now have two emerging innovations—LESS and NOTES—that allow doctors to perform surgeries with a minimum of cutting and virtually no scars. Pain levels are significantly reduced as well with these scarless surgeries, allowing patients to get home and back to activities of daily living much quicker.

Laparoscopy (from the Greek words lapara, or flank, and skopion, a means of viewing something) is a surgical procedure in which small (1-2 cm) incisions are made and plastic tubes (trocars) are inserted through them to keep the channel open so that tools—including surgical instruments and the viewing telescope (laparoscope) with its mini-camera—can be inserted. When the abdomen is inflated with carbon dioxide, organs can be pushed out of the way for access and better vision, allowing the surgeon to work while watching an external video monitor. The tools can be manipulated to make necessary repairs, just as if the abdomen had been cut open the old-fashioned way, but without the surgeon's hands ever entering the patient's abdomen.

LESS (laparoendoscopic single-site surgery) takes laparoscopic surgery to an entirely new level by reducing the process to a small cut in the belly button. "LESS is performed through a single incision in the patient's navel," explains Inderbir S. Gill, M.D., Chairman of Urology at the Cleveland Clinic, and a pioneer who recently performed LESS live-donor nephrectomies in nine consecutive kidney donors for kidney transplantation. "All aspects of kidney harvesting were completed though the navel. Instead of a visible six-inch scar and a six-week recovery period, patients recovered within two weeks and had a tiny scar hidden by their belly button."

Because it only uses one port with multiple channels for the surgeon to simultaneously pass various surgical instruments, LESS may also reduce complications that might occur after traditional open and even laparoscopic abdominal surgery. "My patients report less discomfort and have faster recoveries compared to those undergoing traditional laparoscopy," Dr. Gill says.

NOTES (natural orifice transluminal endoscopic surgery) bypasses normal laparoscopic incisions altogether. Instead, the surgeon gets to an appendix, prostate, kidney, or gallbladder through one of the body's natural cavities, such as the mouth, vagina, or colon. "Being able to perform major surgery inside the abdomen and chest through natural orifices is a very intriguing concept," reports Dr. Gill. "Potential advantages of this would be the ability to have scar-free and, hopefully, pain-free surgery. This is what has caught the imagination of the public."



6 New Strategies for Creating Vaccines for Avian Flu

Use of new strategies for creating vaccines for avian flu, including genetically-engineered virus-like particles (VLPs) as the basis for vaccines.

Flu pandemics pose an enormous threat to everyone. As the virus spreads and continues to reinvent itself—and with a lack of broad immunity in humans—pandemics are real concerns and inevitable. Most epidemiologists agree that the world is overdue for another lethal flu pandemic.

Recent outbreaks of avian influenza (bird flu), triggered by duck and chicken virus that can pass from the birds to humans, remains a continued threat. Experts believe that it is only a matter of time before this bird flu mutates and starts to spread from person-to-person around the globe with the help of international jet travelers. Without the protection from a special avian flu vaccine, it's estimated that even a mild strain of the virus could severely sicken a half million Americans and kill more than 200,000. By comparison, the typical flu we get each winter kills about 36,000 annually in this country.

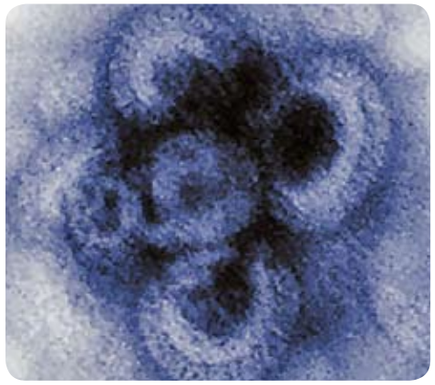
Scientists are working to engineer effective vaccines against this killer bird virus, in particular against the most common and deadliest strain of avian flu, H5N1. Most vaccines employ a killed virus to stimulate the immune system. These vaccines have to be formulated to match the mutating flu strains and can take several months to manufacture using specially grown chicken eggs.

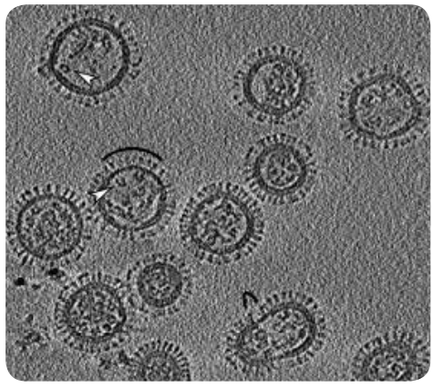
A newer vaccine approach that uses a mock version of the bird virus called a virus-like particle (VLP) may offer a better solution to protect people against infection from the deadly avian virus.

To create VLPs for avian flu, scientists build a structure similar to a virus except for the genetic material required for viral replication. Once injected into the body, VLPs attach to cells and trigger an immune response sufficient to protect a person if they become exposed to the virus. A recent human study reported that an experimental VLP vaccine produced a response against H5N1 in up to 94% of patients.

VLPs have several advantages over traditional flu vaccines: they are easier to develop, produce, and manufacture. Researchers only need to know the genetic sequence of the virus in order to create a vaccine against it; live virus is not needed to produce a VLP vaccine.

"Our niche is our ability to react quickly," says Penny M. Heaton, M.D., who has been involved in the testing of experimental VLPs against avian flu. "If the World Health Organization sees a new strain emerging in Asia and they know it can cause a pandemic, once they get us the genetic sequence of that strain, we can have the first vaccine produced in 10 to 12 weeks, which is half the time for egg-based vaccine production."





5 Percutaneous Mitral Valve Regurgitation Repair

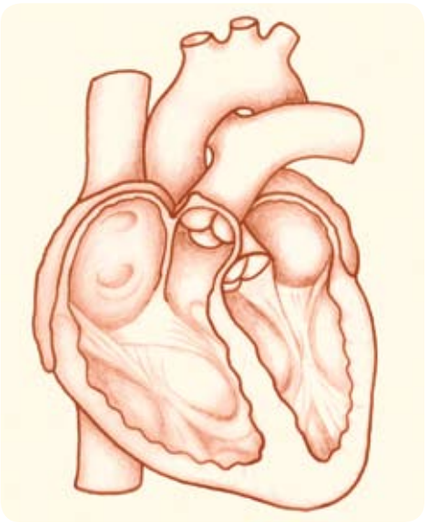
Use of a special clip to percutaneously repair mitral valve regurgitation (MVR).

The patient, the self-described "only Democrat from Crawford, Texas," was in severe distress and his life was at risk. After undergoing open-heart surgery, he had developed an infection in his sternum, requiring removal of the sternum approximately two years prior to presentation. Subsequently, he was diagnosed with severe mitral valve regurgitation (MVR), which forced his heart to work harder, caused his breathing to become labored, and made walking more than a few yards more like a marathon activity. Additional open-heart surgery was needed to repair his mitral valve, but the man's frail physical condition and lack of sternum made it way too risky.

The mitral valve is a one-way valve that connects the left atrium to the left ventricle of the heart. MVR occurs when the valve does not seal completely, allowing blood to trickle back into the left atrium, causing the heart and lungs to swell. It's estimated that four million Americans suffer from MVR, with about 40,000 undergoing highly invasive surgical repair. This entails a heart-lung machine, slicing through the sternum, and finally valve repair or replacement. Hospitalization typically lasts three to five days, followed by a lengthy recovery at home.

The man from Crawford was in luck. "His son-in-law read about the experimental non-surgical MVR procedure we were doing with a special clip and was eventually able to enroll him in the EVEREST II [Endovascular Valve Edge-to-Edge REpair STudy] clinical study," says Samir Kapadia, M.D., an interventional cardiologist in the Cleveland Clinic Department of Cardiovascular Medicine who has performed many of the non-invasive procedures. "He left the hospital two days after the three-hour procedure in the cath lab. Three years later, he's gone from severe limitation to becoming active and doing almost everything he wants."

With the innovative clip—a tiny barbed, wishbone-shaped device now in the eighth year of human testing—the heart is fixed non-surgically from the inside out. A catheter is carefully guided through the femoral vein in the groin, up to the heart's mitral valves. The clip on the tip of a catheter is then clamped on the center of the valve leaflets, which holds them together and quickly helps restore normal blood flow out through the leaflets. When the procedure is finished, a sterile bandage is applied over the small cut on the groin.



"The technology is extremely safe. While the procedure works well for most people with moderate to severe MVR, if the clip does not work for some reason, surgical repair or replacement of the valve is still a possible option," says Dr. Kapadia. "If the EVEREST trial results are positive, and the device is approved by FDA which could be within two years, it can change the way that we approach patients with mitral valve regurgitation."

4 Multi-Spectral Imaging Systems

Improvements in multi-spectral image analysis to assess multiple protein pathway configuration in a single sample/cell.

Look closely at a black and white photograph taken long ago at a family gathering and you will see shades of gray in everything from furniture to clothing. Is your mother's outfit gray? Might it be blue? Or is it actually a yellow suit that happens to appear dark in the photo? In the same way that color photographs provide more information about a scene than black and white photographs, multispectral imaging can provide more information about the "color" properties of a tissue sample than a simple RGB color camera.

For many decades, pathologists have used immunohistochemical staining for protein distributions to examine tumor sections on a microscope, often one equipped with a color camera. These color cameras detect only three visible wavelengths that mimic the human eye: red, green, and blue. The human eye and color cameras work very well for looking at the single stains (typically a brown DAB stain for the protein distribution and a blue hematoxylin counterstain to visualize the tissue architecture). However, in order to look at the distributions of multiple proteins, pathologists currently must look at one microscope slide for each protein, which adds time and can only give a reading on the overall protein expression in the tumor, and not on the protein expressions in individual cells.

"And that means more 'seat time' for the pathologist," explains James R. Mansfield, a leading spectral imaging scientist. "The pathologist may now have to examine as many as four or five different tissue slices under a microscope to detect and quantify multiple clinically important proteins in a single tumor sample."

The introduction of multispectral imaging technology and new multispectral imaging systems has erased this problem by enabling researchers to spectrally resolve up to five or six chromogens (colors) in a single tissue section, even if those chromogens are spatially overlapping and co-localized.

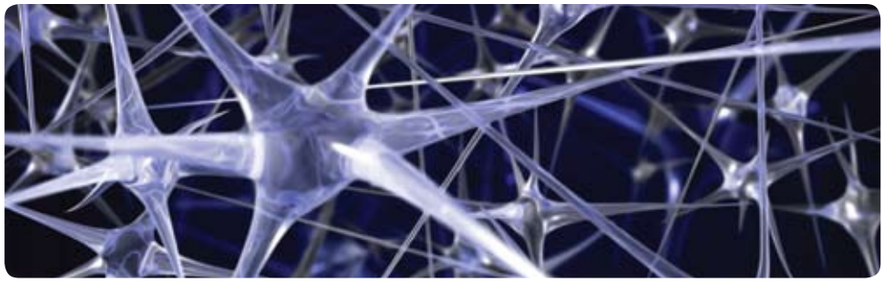
"Multicolor labeling is common in many clinical methods such as flow cytometry, which analyzes homogenized samples," says Mr. Mansfield, "but multicolor methods that maintain the morphology and pattern of distribution of the protein are changing the way researchers can view their samples."

Once the sophisticated imaging system is attached to a standard microscope, researchers can stain up to four proteins using different colors and look at tissue samples with 10 to 30 different wavelengths, allowing for the accumulation of more information than is currently available. This helps researchers to better understand the complicated signaling pathways in cancer cells, and to develop more targeted therapies, which might allow physicians to better personalize treatment for individual patients.

"By combining multispectral imaging technology with sophisticated automated morphologic segmentation and image analysis methodologies," says Mr. Mansfield, "we now have a new toolbox for the exploration of cellular phenotypes and events in solid tissues."

3 Diaphragm Pacing System

Use of a diaphragm (phrenic nerve) stimulator to enable paralyzed patients to breath without the assistance of a mechanical ventilator.



On a warm summer day in Chicago in 2002, Laszlo Nagy, 36, was riding his motorcycle when his passenger suddenly reached over and twisted the throttle to make the bike go faster—right into the path of an oncoming car. Nagy hurtled through the windshield, broke his neck, and was initially listed as dead on the scene. Revived and raced to a trauma center, the stockbroker spent the next several months in the hospital and rehabilitation center connected to a mechanical ventilator. Unable to move his four limbs but able to shrug his shoulders, he began to learn how to live as a C-3 tetraplegic.

It certainly wasn't easy, especially because of the ventilator. "I cried myself to sleep every night," says Mr. Nagy of the noisy ventilator that connected with tubing through a hole in his neck, and allowed his lungs to fill with oxygen. "Once I got my power wheelchair, the 100-pond ventilator was placed on a tray on the back, with the battery down below." Nagy had mobility but not without significant anxiety. "If one of the many hoses got disconnected, I had to be near someone who knew how to put it back in. And if my battery ran out, I would be at great risk," he says. "It was a very challenging lifestyle."

Mr. Nagy's life took a dramatic turn for the better in June 2005 when he had an experimental diaphragm pacing system implanted that would replace his bulky ventilator. Laparoscopic surgery was performed by Anthony F. DiMarco, M.D., who developed the novel device along with his Case Western Reserve University colleague, Raymond Onders, M.D. Four electrodes were connected to the phrenic nerves on Nagy's diaphragm, the dome-shaped muscle below the ribs that causes air to flow to the lungs. Wires from the electrodes run to and from a control box about the size of two decks of playing cards worn outside the body. When the electrodes are stimulated by current, the diaphragm contracts and air is sucked into the lungs. When not stimulated, the diaphragm relaxes and air moves out of the lungs.

Two weeks after the surgery, Mr. Nagy was gradually weaned off his ventilator and learned to breathe with his new pacing system. "It didn't take long before I could get reasonable, sustainable, and comfortable breaths," he says.

Mr. Nagy never could have imagined how his life was going to change because of the pacing system. "I now own my own home. I got married and my wife and I have traveled all over the country. We are now expecting a baby in April."

2 Warm Organ Perfusion Device

Warm organ perfusion device to preserve organs for transplantation during transplant.

Once a human heart becomes available for transplant, the race is on. A team of cardiac specialists immediately leaves the hospital by the fastest means possible to get to the donor who is about to die. Once the heart is retrieved, the clock is ticking. The excised heart, placed in a plastic bag and packed in a store-bought picnic cooler filled with pounds of ice, has to be transplanted within 240 minutes to achieve the best results.

A human heart in a picnic cooler? It's the way it's been done for 30 years. When the flow of warm oxygenated blood to the heart is stopped and the heart is removed and placed in a cooler, the heart begins to slowly decay, even when packed in ice, which is why there is a four-hour window for replacement.

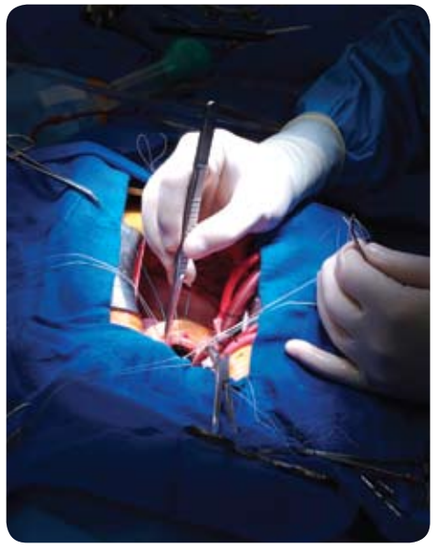
On any given day, about 4,000 people are waiting for a heart transplant in the United States. "Transporting a donor heart is a very crude process, but efficient," says Tomislav Mihaljevic, M.D., Staff Cardiac Surgeon at the Cleveland Clinic, and a member of the heart transplant team. "The picnic cooler has worked very well for many years and benefited thousands of patients. Granted, it's not the optimal way to transport a heart."

Now, with the world's first warm blood perfusion system approved for use in Europe, and undergoing its pivotal multicenter testing phase in the United States, there is finally a better way to transport a variety of living organs, including the heart.

"The device is actually a portable miniature heart/lung machine," says Dr. Mihaljevic of the warm organ perfusion equipment. "When the heart is harvested, we take a liter of blood from the donor and put it into the device, which recreates conditions found inside a healthy body. The heart is then placed into the device and the warm blood is slowly pumped through it. The heart naturally starts beating," And the heart keeps beating, right up until the time it is transplanted. In tests, hearts have kept beating for upwards of 12 hours in the warm organ perfusion device, greatly expanding the four-hour transplant window.

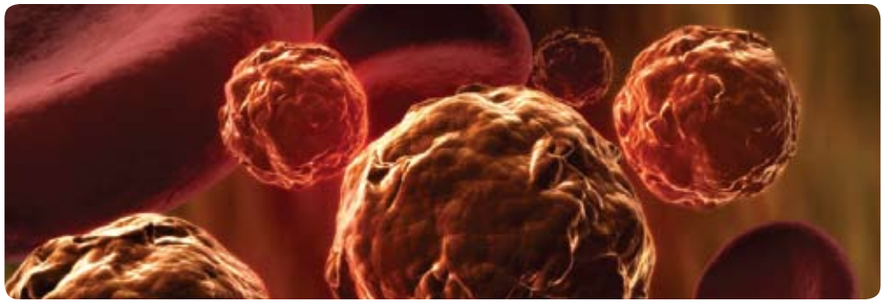
"We have transplanted three hearts with this new technology," says Dr. Mihaljevic, "and achieved excellent results. Heart function was measurably better. The patients recovered very quickly. I am very satisfied by the results."

The warm organ perfusion device is a game changing innovation, says Dr. Mihaljevic. "Once it receives FDA approval, the technology will impact not only the way that we do heart transplants, but the way that we do other solid organ transplants with the kidney, liver, and lung."



1 Use of Circulating Tumor Cell Technology

Use of new technology to measure circulating tumor cells as a predictor of success of chemotherapy.



There are almost 10 million cancer survivors in the United States. Receiving the news that cancer has recurred and spread after having been given a clean bill of health is shocking and bewildering to most, and oftentimes more psychologically devastating than the original cancer diagnosis.

Many people react with fear when given the news about their metastatic cancer, others with anger, and some with a sense of utter hopelessness. When breast, colorectal, or prostate cancer becomes metastatic, it immediately raises numerous concerns and important, questions. What is the best therapy? How do I make the treatment choice? Should I consider joining a clinical trial?

Many recurrent cancer treatment choices are based on how the disease is progressing. To determine this, doctors look for signs, which are traditionally provided by imaging or tumor marker tests at certain points during therapy.

Now there is another option: use of a new technology to measure circulating tumor cells (CTCs) in a sample of blood to aid in the early detection of rogue cancer cells in patients with recurrent cancer. This is a different kind of test that can help people learn how their therapy is working much sooner. The technology allows patients to monitor their progress at any point along their treatment course, and guides the doctor in adjusting therapy as needed.

CTCs are cancer cells that have broken away from an existing tumor cell and have entered the bloodstream. The presence of these cells in the blood can provide valuable insight into the progression of the cancer. Clinical studies of patients with metastatic cancers of the breast, colon/rectum, or prostate have reported that the monitoring and detection of CTCs can actually predict whether a patient's prognosis is more or less favorable.

This blood test captures, identifies, and counts CTCs in a tube of blood. Using a predetermined cutoff number—5 CTCs for metastatic breast and prostate cancer; 3 CTCs for metastatic colorectal cancer—the test can specifically predict a patient's probable outcome.

"This technology has enormous promise," says Daniel F. Hayes, M.D., Clinical Director of the Breast Oncology Program at the University of Michigan Comprehensive Cancer Center in Ann Arbor. "I regularly use it in my clinic. In the end, the benefit of this technology is that it will give us a snapshot of what cancer is doing right now without having to biopsy the patient. That is the real hope and excitement that this test offers."

Where Are They Now?

Top 10 Medical Innovations for 2007

1. Cancer Vaccines: These targeted therapies are being used to prevent cancer and treat patients more specifically according to the type of cancer they have. One example of a cancer vaccine is the HPV vaccine developed to prevent cervical cancer caused by human papillomaviruses.

This has been a clinical and commercial success, with sales over $1 billion for 2007-2008. This cervical cancer vaccine is now widely used, with 25% of American teenage girls vaccinated in 2007.

2. Designer Therapeutics Using Selective Receptor Antagonists: Novel therapeutics have been created to block receptor activation that leads to improved patient outcomes. Examples include therapeutics that: block the peripheral side effects—such as constipation and nausea—of opioid medications for pain which can adversely affect patients and lengthen hospitalizations; and control the body's stress response to mediate eating and smoking.

There have been some setbacks in this field, with the recent withdrawal of an SRA-obesity drug from U.S. market trials, and the suspension of the drug in the EU because of a poor risk/benefit ratio in clinical practice.

3. Neurostimulation for Psychiatric Disorders: Neurostimulation, such as deep brain stimulation (DBS), is emerging as a significant treatment option for millions of Americans who are suffering from treatment-resistant depression and treatment-resistant obsessive-compulsive disorder.

Investigational results continue to show effectiveness of neurostimulation in the treatment of resistant forms of depression and OCD. There is also a growing acceptance of DBS for treatment of Parkinson's, essential tremor, and dystonia.

4. Optical Coherence Tomography (OCT): This noninvasive imaging technology is used in the treatment and diagnosis of eye diseases, such as diabetic retinopathy and macular holes. This technology has become ubiquitous in the identification and treatment of eye disease. In addition, OCT is being developed for intravascular imaging to assess unstable plaque in coronary arteries.

5. Bronchial Thermoplasty (BT): BT involves the controlled application of heat in the lungs to improve pulmonary function and reduce asthma symptoms. This therapy is used to ward off asthma attacks.

In a recent international study with patients with severe asthma, 50% of the study subjects were able to completely stop taking their inhaled steroids after undergoing BT. One year later, they were still having positive asthma control. Commercial acceptance, however, is still a few years away.

6. Ranibizumab: This drug therapy inhibits uncontrolled blood vessel formation in the eye, which is the primary cause of age-related macular degeneration, and the leading cause of new blindness in older Americans.

The drug has since become a clinical and commercial success ($700 million in sales since introduction) and remains the standard of care for age-related macular degeneration; new trials are testing combination therapies, which may allow similar or improved outcomes with fewer treatments.

7. Endografting: This is a minimally invasive repair technique traditionally used in cardiology and now being used to treat vascular disease, including thoracic abdominal aneurysms.

This technique has since gained worldwide acceptance, with high success rates reported in trials in Asia. In the U.S., one device is approved by the FDA and competing devices are undergoing clinical trials.

8. Targeted cancer therapies: This involves using second generation, small molecule tyrosine kinase inhibitors to block or modulate disease and provide treatments for advanced cancers, such as renal cell carcinoma.

An evolving success, with significant advances already reported. Lapatnib gained FDA approval in 2007 for patients with advanced, metastatic breast cancer that is HER2 positive.

Where Are They Now?

9. Left Ventricular Assist System (LVAS): This is the first implanted ventricular assist device that senses when to increase or decrease the rate of blood flow. The device takes over most of the function of the left ventricle, and helps generate the force necessary to propel oxygen-rich blood throughout the body.

This has been a commercial success and continues to give new hope for patients awaiting heart transplants. There have been several successful clinical trials and subsequent FDA approval for devices used as bridge-to-transplant. Several commercial models are now available from different manufacturers. New generation devices that minimize the biologic impact of support and that incorporate increasingly sophisticated responsiveness to the body's variable circulatory demands will continue to expand the utility of this revolutionary approach to end-stage heart failure.

10. Convection-enhanced delivery of drugs: This emerging drug delivery method is being used to administer medication directly to the site where it is needed, without exposing the rest of the body to a drug's effects.

At this time, it's still too early to judge the technology's overall success. While the initial phase III trials failed to show benefit of the experimental drugs delivered via CED, other studies have shown that it is an effective drug delivery technique. Advancements in CED catheter technology and real-time imaging of drug distribution made over the past year are leading to the development of a new series of clinical trials for both brain tumors and movement disorders.

Top 10 Medical Innovations for 2008

1. Flexible Intralumenal Robotics: This novel catheter-based technology allows precise remote manipulations within the intra-luminal space with precision and reproducibility that surpasses human capabilities. This technology is likely to have applications in urology, cardiology, cardiac surgery, and other specialties.

Increasing clinical experience has been acquired for this truly cutting-edge device technology in the past year, particularly in interventional cardiology. It has proven especially useful in electrophysiology applications to assist in catheter positioning during ablation procedures; however, this technology holds great promise for wide-ranging catheter-based technologies such as endovascular grafting procedures.

2. Percutaneous Aortic Heart Valves: For high-risk patients, a technique has been developed that involves inserting a new expandable wire mesh valve with internal valve leaflets. The valve is inserted through a groin or small chest wall incision and then fed up through a catheter into position with X-ray screening. The balloon is inflated to secure the new valve.

The percutaneous insertion of aortic valve prostheses are quickly becoming a viable treatment option for high-risk cases, while increasing experience and improved instrumentation will lead to its adoption in elective cases as well. Different versions of this technology are now undergoing clinical trials in the U.S., while the total worldwide experience now numbers in the thousands.

3. RNA-based Therapeutics: This particular innovation uses RNA antisense technology to treat patients who are unable to reach their targeted cholesterol levels with statins alone or who are statin intolerant. The therapy is intended to reduce the production of ApoB-100, a protein that carries certain forms of cholesterol and triglycerides in the bloodstream.

This remains a compelling and very active area of research and development. Agents are in various stages of clinical trials for a diverse range of conditions, including viral infections, cancer, macular degeneration, and hereditary hypercholesterolemia.

4. Convergence of Advances in Genome Scanning and Informatics to Support Clinical Applications: New genetic testing can be used to develop personalized risk assessments and disease management plans for a variety of genetically caused diseases.

There has been a very rapid development during the past couple of years, with the number of commercially available genomic tests growing by 25% annually; this has been especially evident in hematology and oncology. Concerns and uncertainty about reliability and interpretation of results remain an issue. Clinicians are trying to corroborate the findings yielded by this technology with clinical events.

Where Are They Now?

5. Oral anticoagulant Drugs for Treating and Preventing Thrombosis: Newer anticoagulant treatments are being introduced with the goal of curbing complications such as bleeding and thrombosis.

In the past year, increasing experience has been obtained with new generation oral anti-coagulants (such as anti-Factor X) in various stages of clinical trials. Compared to existing therapies, these agents continue to hold great promise for providing effective anticoagulation with decreased complications and easier monitoring.

6. Live Attenuated Influenza Vaccine for Children as Young as Two Years: Nasal drops containing live attenuated flu can be used as a vaccine in lieu of needles, and provide effective protection from influenza for this high-risk population.

During the past year, studies have demonstrated the increased efficacy of live influenza vaccines, while the nasal route of delivery (bypassing needle administration) is especially valuable in children. This expanded the U.S. patient population by 10 million. However, use of live attenuated virus was not approved for children aged six months to two years.

7. Image Fusion for Diagnostic and Therapeutic Use: This technology is used to diagnose medical problems, both anatomic and physiologic in nature, as well as to assist minimally invasive procedures—such as stent placement or tumor ablation.

SPECT/CT imaging in cardiovascular disease is still in development for most applications but holds promise for combined imaging of the myocardium and coronary arteries in ischemic heart disease or as a tool to determine the inflammatory nature of plaque burden in larger vessels. SPECT/CT continues to be useful in oncologic imaging, especially for neuroendocrine tumors or melanoma and can be a useful adjunct in localized inflammatory lesions such as infected orthopedic prostheses.

8. Implanted Device Allowing Neural Control of Objects by the Severely Disabled: Novel communication interfaces are being developed for severely motor-impaired individuals to provide the ability to control devices and to potentially restore limb movements. This interface system is designed for individuals with spinal cord injuries, stroke, ALS, and other central nervous system injuries.

Devices remain in early clinical trials for the treatment of patients following spinal cord injury or those suffering from degenerative neurological diseases such as ALS (Lou Gehrig Disease).

9. Engineered Cartilage Products for Joint Repair: Natural biomaterials have been developed to replace joint cartilage tissue damaged from injury or arthritis. The materials are surgically implanted into the joint with the intent to restore the damaged cartilage and avoid joint replacement surgery.

Second-generation products from several companies are undergoing FDA clinical trials with launches in the U.S. not likely until 2009.

10. Dual Energy Source Computed Tomography (CT) Imaging: The CT device features two X-ray sources and two radiation detectors, which allow for imaging of patients more quickly and with less radiation. The speed at which the dual-source scanner operates allows physicians to image patients with high or irregular heart rates, which used to be a significant limitation of this technology.

Increased speed in image acquisition provided by a dual energy source has greatly expanded the application of CT imaging in cardiac disease. The associated multi-row detection technology has improved device portability that allows real-time imaging to be performed to assist a vast number of applications in orthopedics, neurointervention, and in the ICU setting. The technology continues to improve, offering better resolution and lower radiation dose.

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Top 10

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