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How New Heart-Scanning Technology Could Save Your Life

More and more, doctors are diagnosing coronary disease without any invasive tests whatever

By CHRISTINE GORMAN, ALICE PARK

Mike Fackelmann had no reason to think he had heart disease. Although his cholesterol was a touch on the high side, he had never experienced any chest pains and had just passed a stress test with flying colors. So last November, when a cardiologist at the Cleveland Clinic Foundation Hospital asked the then 49-year-old registered nurse to help demonstrate an experimental new cardiac scanner, neither the physician nor Fackelmann expected to see anything out of the ordinary. The idea was simply to slide Fackelmann through the machine and show what finely detailed images of the heart it could produce.

The favor Fackelmann did may well have saved his life. The scan revealed a major blockage in one of his coronary arteries. A few days later, doctors propped open the dangerously clogged blood vessel with a stent, thereby preventing what could have been a heart attack. "I would have been one of those guys who was just out jogging with my son or playing basketball and died," Fackelmann says. "There was never any reason for me to suspect that there was such a dramatic lesion in my heart."

What makes this story all the more remarkable is that the image that changed Fackelmann's future was generated without any kind of surgery. For years, the gold standard for discovering the location of blockages in a patient's coronary arteries has been a procedure called a cardiac catheterization, in which a specialist inserts a probe through an incision into a blood vessel in the groin, then snakes it up toward the heart, where an opaque dye is released.

Any lesions or plaques that block the arteries then show up on an X-ray picture called an angiogram. And if you don't consider catheterization real surgery, you don't understand how invasive and delicate an operation it actually is. The process can take anywhere from four to six hours and carries a 1% risk of serious complications, including death, from wayward catheters that can tear the delicate artery walls--which is why doctors don't order it lightly. Yet 20% to 40% of patients who take the risk turn out not to have needed it: they show no significant blockages in their arteries.

Or at least that's where things stood until recently. The past 18 months have brought a

wave of advances in cardiac imaging, leading many doctors to wonder whether it's time to change the way they diagnose and treat heart disease. Leading the way are improvements in CT (for computed tomography) scanning, which uses highly specialized X-ray machines to take multiple, finely layered pictures of the heart and surrounding blood vessels. Sophisticated computer programs sort the data to generate amazingly detailed, three-dimensional images like the ones that alerted Fackelmann's doctors to his hidden heart problem. Advances in other techniques like MRI (magnetic resonance imaging) have astonished physicians with the clarity of details now available to them on the inner workings of the heart.

What that means is that millions of patients will probably get the treatment that better matches their condition. Some doctors are already starting to use the scans to figure out which of their otherwise healthy-seeming patients need to be taking cholesterol-lowering drugs like statins, and may even be able to decide what to do in marginal cases without having to resort to an invasive angiogram. Patients with a clean scan, on the other hand, can feel confident that they don't need statins or other medication, along with their potential side effects.

The most dramatic benefits of the heart-imaging revolution will probably show up first in emergency rooms. About 5.5 million people go to the hospital each year complaining of chest pain. Most of them are not suffering a heart attack, but it can be very tricky to separate out which ones have indigestion or a strained muscle from those who have something much, much more dangerous. A noninvasive test that shows whether or not the cardiac blood vessels are blocked could help make the diagnosis a lot easier. "We used to say to patients who came in with chest pain [and no other signs of cardiac disease], 'I don't think you have coronary disease,'" says Dr. Mario Garcia at the Cleveland Clinic, which has been one of the early adopters of cardiac CT scans. "Now I can tell them, 'I know you don't have coronary disease.' That's a big difference."

Medical groups are racing to keep up with these changes. In July, the American College of Cardiology and the American Heart Association published their first guidelines on how to train doctors to perform the new cardiac scans. Three studies have shown that cardiac CT is 90% accurate at picking up blockages like Fackelmann's. But no standards have been written yet for determining under what conditions using the new scans makes the most sense, and for which patients. More definitive answers may be forthcoming at the annual American Heart Association meeting in November, when several research groups are expected to present their latest studies.

The technological boom has come so fast that doctors and patients are faced with the challenge of sorting the scans from the scams. Medicare and insurance companies are looking with growing alarm at the overall surge in the use of expensive imaging scans for all parts of the body. The reasons for the increase are complex--and hotly disputed--but many cardiologists are worried that fights over which procedures get reimbursed and who gets to order them could strangle the latest innovations.

Meanwhile, no one has given up on more tried-and-true scanning techniques. According to the IMV Medical Information Division of Des Plaines, Ill., doctors perform annually at least 11.5 million echocardiograms, which use sound waves to produce pictures of the internal structures of the heart, and more than 9 million nuclear perfusion scans, which use mildly radioactive tracer molecules to measure

how well the cardiac muscle is nourished. Improvements in computer processing power and software have made these tests more reliable and more conclusive than ever before. Stress tests, which help doctors detect ischemia, or lack of blood flow to the cardiac muscle, can be performed using either echocardiograms or nuclear scans. "Echocardiograms and nuclear perfusion scanning are the bread and butter of cardiac care," says Dr. Pamela Douglas, chief of cardiovascular medicine at Duke University Medical Center in Durham, N.C., and president of the American College of Cardiology. "They aren't going away anytime soon."

The trouble is that there's no single type of scan that easily and inexpensively shows you everything you need to know about the heart. In addition, some tests are better at evaluating anatomy--the physical structure of the heart--while others tell you more about how well various parts are working. Doctors need to know both kinds of information before deciding the best course of treatment. Frequently, a new set of answers raises new questions, however, which require more extensive testing. The ultimate goal, cardiologists say, is to find the single test that provides "one-stop shopping" and eliminates the need for invasive or multiple diagnostic scans. That test doesn't exist yet, but a look at the latest advances in noninvasive imaging suggests it is getting closer.

Sharply detailed CT scans of the brain have been available for years, but it has taken much longer to get similar images of the heart. The reason is simple: the brain doesn't move. The heart does, of course, constantly, which means that conventional images are largely a blur. Some rather small (yet vitally important) blood vessels that lie on the surface of the heart compound the problem.

But the latest CT scanners address both drawbacks by dividing the heart into 64 imaginary slices, compared with 16 slices in the most common older scanners. This higher number increases the resolution of the final image and decreases the amount of time needed to make it. It takes about eight heartbeats to get a complete picture, but sophisticated computer software makes it possible for images to be taken at precisely the same part of the cardiac cycle--ensuring that the heart is in the same position. The downside: people with irregular heartbeats aren't the best candidates for cardiac CT.

Under the right conditions, CT images of the heart are so sharp, however, that they can take a lot of the guesswork out of diagnosing heart disease. "There's a fairly large middle category of people where it's not clear how much heart disease they actually have," says Dr. David Bluemke at the Johns Hopkins Hospital in Baltimore, Md. "Their cholesterol is high. Their blood pressure is high. They have a few risk factors. That doesn't mean they need to go to the catheterization lab. But it sure would be nice to get a quantitative measure of their disease."

Some doctors in emergency rooms are already starting to count on cardiac CT for what they call a "triple rule-out." Here's a typical situation: a middle-age woman walks in complaining of chest pains but otherwise seems fine. The biggest concerns are that she might be having a heart attack, that her aorta may have developed a tear or that she has a major clot in the blood vessels of the lungs. Any of these could swiftly be deadly. Her electrocardiogram comes back normal, and blood tests indicate no cardiac damage. With no compelling reason to suspect a heart attack, it's hard to make the case for ordering a cardiac catheterization. But because she continues to complain of chest pains, doctors are reluctant to send her home. So they keep her under observation, waiting to see if anything happens. A 64-slice CT scan of her heart

and lungs could provide enough detail to rule any of those conditions in or out on the spot.

Or at least that's the idea. Cardiac CT is not foolproof. Unlike catheterization, it doesn't yet produce clear enough pictures of some of the smaller arteries of the heart. And any arterial plaques that contain calcium deposits, which typically appear in older people, show up like white blobs, so that the blockage could be partial or total (see box). Then there's the issue of radiation. A typical cardiac CT scan exposes a patient to 50 to 80 times the amount of radiation in a series of full-mouth dental X rays. Researchers hope to figure out ways to decrease the dose soon.

Before 64-slice CT appeared on the scene, many physicians thought the future of cardiac scans belonged to a completely different technology: magnetic resonance imaging. Instead of X rays, MRI uses powerful electromagnets that are tuned to detect the hydrogen found in water--which in turn is present in most of the body's soft tissues. An MRI machine can produce astonishingly detailed images of the heart. Just as important, it can also determine how healthy the cardiac tissue is. For example, in a heart-attack patient, an MRI can pick out precisely which sections of the cardiac muscle are getting less blood than they need and by what amount. And, unlike a CT scan, it does all that without subjecting the patient to radiation.

Advocates of MRI admit that CT scans probably have the edge when it comes to imaging the heart's arteries, but that's about all. "Coronary arteries are only a small part of the heart," says Dr. Raymond Kim, co-director of the Duke Cardiovascular Magnetic Resonance Center. MRI is better at telling you how well the heart is pumping, how healthy its walls are and what shape the valves and chambers are in. In other words, says Dr. Edward Martin of the Oklahoma Heart Institute in Tulsa, "MRI has the potential to do everything."

MRI is also ideal for scanning children with congenital heart problems, since repeated radiation exposure in youngsters leads to an increased risk of developing cancer as adults. But again there are drawbacks. MRI scans are much more expensive than CT scans, and generating and interpreting them require lots of training. Furthermore, the magnet exerts a powerful attractive force on any iron-containing metals, so special precautions must be taken to prevent accidents.

As for cost, some MRI experts predict that will become less of an issue. "Right now many heart patients have to undergo a combination of tests that add up to more than the expense of one MRI scan," says Dr. Andrew Arai, a researcher at the National Heart, Lung and Blood Institute in Bethesda, Md., who is studying the use of cardiac MRI in the emergency room. If a single MRI could replace the need for lots of echocardiograms, cardiac catheterizations and nuclear perfusion scans, it might be worth the price.

Some of the older diagnostic standards are undergoing a technological makeover of their own. Echocardiogram machines are getting smaller and smaller, and their output is increasingly being digitized, which allows doctors to calculate more accurately the ability of the heart to function. And new radioactive markers are making nuclear perfusion scans shorter and more precise.

The future, however, may belong to whoever can figure out how to make all these imaging technologies work together. One approach combines the anatomical accuracy

of CT imaging with the functional information provided by a type of nuclear scan called positron-emission tomography (PET). Still in its early days in the clinic, PET/CT could help doctors see how much of the cardiac muscle is still alive after a heart attack and whether a bypass operation, balloon angioplasty or stent surgery would help damaged areas recover.

Even the sharpest pictures can't show you everything. Over the past few years, it has become increasingly clear that not all plaques that form inside a coronary artery's walls are dangerous. Some appear to be stable and don't grow much, whereas others contain an explosive combination of hardened fat and inflammatory proteins that make them likely to burst, triggering a heart attack. Neither CT nor MRI scans can reliably distinguish between the two sorts of lesions. Researchers are developing compounds that are chemically attracted to the inflammatory components of an unstable plaque with the hope of someday tagging trouble spots that need to be treated. But that could take a while.

The latest advances in scanning could backfire, moreover, if they lead to lots of unnecessary surgery. Not every blockage reduces blood flow. Sometimes the other blood vessels that nourish the heart can take up the slack--a situation that's more common than you might think. "We still don't know what to do with patients who have a number of moderate narrowings but no ischemia," says Dr. Roger Blumenthal of Johns Hopkins. "There are no data showing that taking them to the cath lab for stenting or angioplasty affects their outcome."

On the other hand, there is a lot of evidence that lowering cholesterol levels in those patients with moderate arterial blockage greatly reduces the risk of suffering a heart attack or stroke. So a growing number of cardiologists are using the new cardiac scans to determine which of their otherwise asymptomatic patients need more intense medical treatment with statins and other drugs. "It's the perfect setup," says Dr. Christopher Cannon, a cardiologist at the Brigham and Women's Hospital in Boston. "You don't want to wait until you've had a heart attack to manage your cholesterol."

Not surprisingly then, the new cardiac scans are helping to fuel a more aggressive focus on prevention. If a cardiac scan shows your doctor that you have mild coronary artery disease, then, in addition to trying to get your LDL cholesterol level under 70 mg/dL, he or she is probably going to put you on a daily aspirin regimen and make sure your blood pressure is nice and low. "Conversely," says Cannon, "if you have a scan and you're normal, you don't have to start taking five different medications."

Meanwhile, there is still an issue of professional turf left to resolve. High-tech imaging--particularly CT scanning--has long been the purview of radiologists, many of whom don't take kindly to cardiologists encroaching on their territory. After all, it has happened before. Radiologists used to perform lots of cardiac catheterizations but have pretty much given up that technique to heart specialists, in large part because they were simply outnumbered. As for who is best at reading cardiac CT scans, cardiologists argue that they have a better understanding of the heart's anatomy and function, while radiologists point out that the heart is not the only organ that shows up on the images and needs to be evaluated. Some hospitals have split the difference, decreeing that a cardiologist and a radiologist should analyze each cardiac scan.

No one expects any of these concerns to hold the field back for long. Noninvasive imaging has the potential to radically alter the way physicians diagnose and monitor

heart disease. "The whole paradigm for us has been that you don't get that kind of information unless you stick things into people," says Duke University's Douglas. But as cardiac scanners become more powerful and their diagnoses more definitive, sticking probes into people is going to sound less and less like modern medicine--and more like voodoo. --With reporting by Leslie Whitaker/Chicago

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