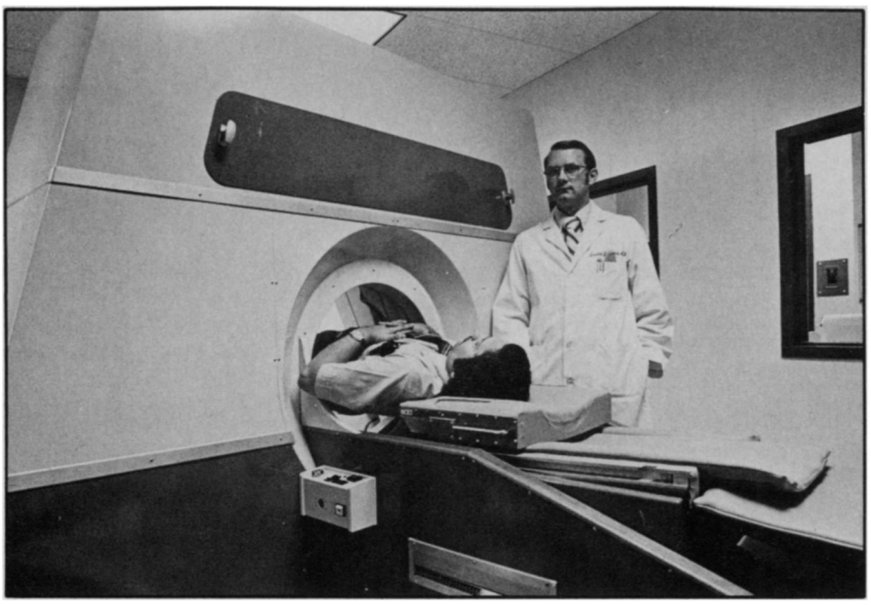
The Bright New World of Brain and Body Scanners

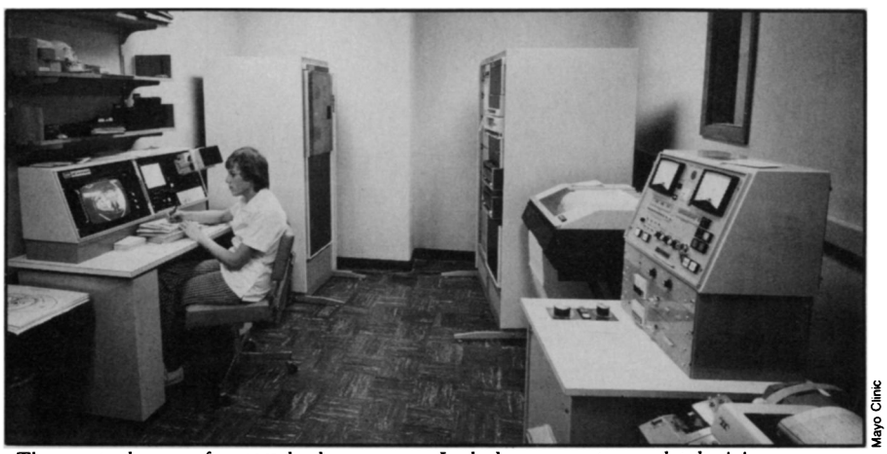
Two years ago, doctors hailed computerized cross-sectional pictures of the brain and body as the greatest revolution in diagnostic radiology since the discovery of X-rays. Clinical experience is proving them right.

BY JOAN AREHART-TREICHEL



Mallinckrodt Institute of Radiology

Evens with patient inside EMI body scanner, which he's used so far on 300 patients.



Mayo Clinic

The control room for EMI body scanner. Includes computer and television screen.

Several months ago, a man was admitted to the Menorah Medical Center in Kansas City, Mo. He appeared to be suffering from a brain dysfunction. Conventional diagnostic techniques revealed nothing. The man was then exposed to a brain scanner based on a new technique called computerized axial tomography. X-ray images shot from many angles are combined mathematically into a cross-sectional picture of the brain. The scanner revealed that the man had a brain tumor. He was immediately operated on and is alive and well today. Without the scan, physicians at the center say, he may have died.

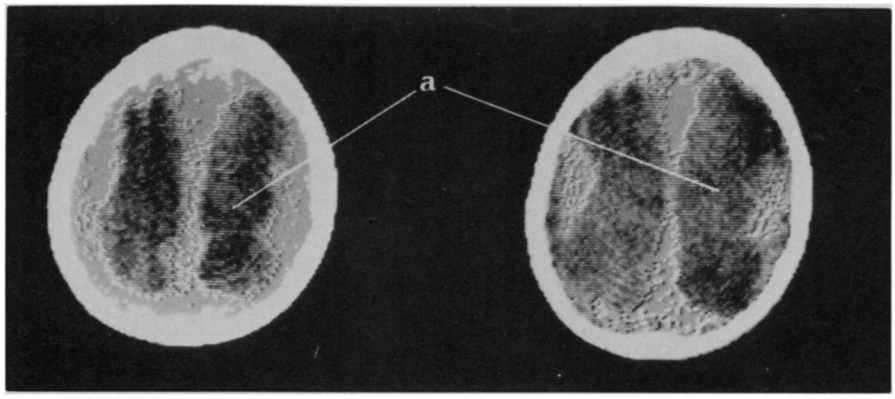
Two months ago, a young woman was found unconscious in her Washington, D.C., home. She was brought to Georgetown University Hospital by her family and underwent conventional diagnostic techniques. No cause for her condition could be found. She was exposed to a brain scanner based on computerized axial tomography. It revealed a blood clot in her brain. Without the scanner, her doctors say, they would not have been able to detect the clot.

Four months ago a woman with severe pain in her hip arrived at the Cleveland Clinic. X-rays of her pelvis, radio bone scans and other conventional diagnostic techniques showed nothing. Doctors used a body scan based on computerized axial tomography. It disclosed an abnormal shadow where the pelvis connects with the spine. They biopsied this area and found it was cancerous. The woman is now receiving therapy, and her pain is subsiding. Without the scanner, her physicians say, a diagnosis of the malignancy would probably have been made, but it would have been delayed.

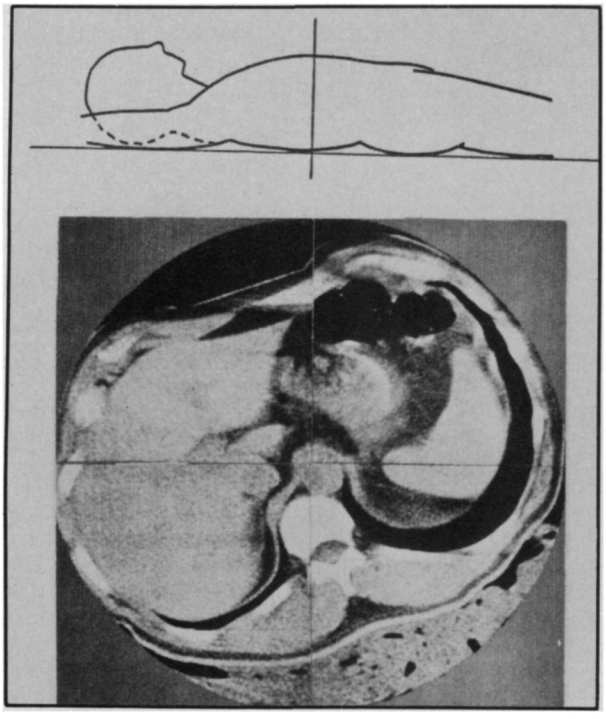
These case histories are but three examples of how brain and body scanners based on computerized axial tomography have been revolutionizing medical diagnosis since they were introduced on the market in late 1973. The scans pinpoint medical problems that other techniques have trouble disclosing or cannot disclose at all, save lives and reduce suffering. They're also safer, painless and quicker than other techniques. Indeed, physicians are so impressed with them that hospitals are rapidly buying them up. It looks as if this is the start of an exciting new era in diagnotic radiology.

It all started several years ago when minicomputers came onto the market. They are extremely powerful and inexpensive. At the same time computers were being used by microscopists to reconstruct three-dimensional images from two-dimensional images shot with X-rays, light, electrons or protons. Astronomers were also using similar techniques to construct two-dimensional images of celestial objects from their radio and X-ray signals. So medical scientists asked: Why couldn't a minicomputer be harnessed to make cross-sectional ("tomographic") images of a particular area of a patient's brain or body, from a series of scanned X-ray measurements? They set to work and soon produced a whole family of new devices based on the computerized axial tomography principle.

The scanners work like this: A patient's head or body is immobilized in the center of a device that has an X-ray beam source on one side and a crystal X-ray detector on the other, directly opposite. The device rotates one degree at a time in a semicircle around the patient's head or body, stopping at each position just long enough to completely scan the target at this angle with 160 separate measurements (or more in some recent machines). The amount of radiation passing through the target is



Pfizer Medical Systems, Inc.



EMI Limited

(Above) An ACTA scan showing two adjacent views of the brain of a patient with hydrocephalus, a condition marked by an excessive accumulation of fluid dilating the cerebral ventricles, thinning the brain and causing a separation of cranial bones. The letter "a" indicates greatly enlarged ventricles. (Left) An EMI scan of the midportion of the body, looking up the body from feet to head. The scan shows the vertebra and spinal cord (bottom center), the spleen (right), the liver (left) and the top of the stomach (black area at top right).

converted to an electrical signal by the crystal, and after about 5 minutes, some 28,800 measurements have been made.

This information is fed into a computer, which reconstructs a two-dimensional, cross-sectional image and displays it on a television screen. Even slight differences in tissue density can be detected and displayed with vivid colors on the screen. A Polaroid camera can then photograph the image for easy reference, while the electronic data are stored on magnetic tape for permanent record.

In the best conventional X-ray pictures, any plane of the body or brain is obscured by blurred images of tissue over and under it, and axial cross sections through the center of the body are virtually impossible to obtain. The new technique thus has the advantage of heightened contrast to point up tumors and other irregularities, while at the same time isolating features of a single, two-dimensional plane. Several planar images can further be combined to give a three-dimensional understanding of the body's interior. The main disadvantage of the new technique is that the images, as they appear on a television screen, are not quite as sharp as those produced on film by conventional radiography.

The first scanner to come on the market was an EMI brain scanner, designed by computer engineer Godfrey Hounsfield and marketed by EMI Limited of Hayes, Middlesex, England, in late 1973 (SN: 9/1/73, p. 134). Then in 1974, both a brain and body scanner, designed by Robert S. Ledley and his radiology group at Georgetown University Hospital, were introduced onto the market. These scanners, known as the ACTA scanners, are now being sold by Pfizer Medical Systems, Inc. In 1975, EMI Ltd. came out with an EMI body scanner as well. Also, Ohio-Nuclear, Inc., of Cleveland started marketing brain and body scanners known as the Delta scanners. Still other companies are also developing scanners. The scanners provide pictures in either black and white or in color. The only advantage of color, physicians feel, is that it makes visualization of details a little easier. Already dozens of hospitals in the United States have purchased these scanners.

The brain scanners are used to diagnose brain tumors, strokes, headaches, enlarging heads in children due to fluid collection or bleeding, and brain abnormalities causing seizures, paralysis and twitching. They're used extensively on patients who've undergone neurosurgery and who are suspected of having complications. "The brain scanners have really established themselves," declares Ronald Evens, a radiologist at the Mallinckrodt Institute of Radiology in St. Louis, and a user of the EMI brain scanner. "They've become available in most neurologic centers and are a key part of the workup of patients. In fact, we are now doing more than 20 scans a day, usually 25 or 26. That demonstrates the confidence that we have in the technique as well as the confidence our referring clinicians have in how it helps."

Although physicians haven't yet had as much experience with the body scanners as they've had with the brain scanners, they are already using them to detect tumors of the lung, pancreas, liver and bone. "Certainly detection of cancer of the pancreas with the body scanner looks as good as its detection with ultrasound," says Ralph Alfidi, a radiologist at the Cleveland Clinic and a user of the Delta body scanner. Also, he says, the use of the body scanner to detect masses in liver metastases is as good as the detection of such masses by nuclear medicine.

The main advantage of the brain and body scanners, physicians tend to agree, is that they offer diagnostic information that other techniques do not. For instance, they have greatly simplified the visualization of brain tumors. And while nuclear scans show up strokes fairly well, they don't show whether a stroke occurred with bleeding or not. Yet such information can be critical. If a patient has suffered a stroke without bleeding, a physician will want to anticoagulate him (thin his blood). But if he has suffered a stroke with bleeding, the physician will not want to anticoagulate him, because he will run the risk of making the bleeding worse.

Still another advantage that the brain and body scanners offer, doctors say, is that scans are often safer to do and less painful for patients than are other techniques. For instance, pneumoencephalography—the pumping of air into the brain to achieve sufficient contrast so that X-rays can visualize abnormalities—has some serious risks. A small percentage of patients undergoing the procedure become paralyzed or even die. The technique can also be excruciatingly painful for patients. Now that the brain scanners have arrived, they are dramatically reducing the use of this procedure. "We used to do about four air studies a week before the EMI scanner," Evens says. "Now we are down to about two a week." Thanks to the brain scanner, he and his team have also reduced the use of another risky, invasive diagnostic procedure—arteriography (the injection of a radiopaque material into the arteries of the brain so that X-rays can visualize them). Roger Lambie, a radiol-

ogist at the Menorah Medical Center and a user of the Delta brain scanner agrees: "The scanner is a much safer procedure than doing an arteriogram or a pneumoencephalogram. It has pretty much replaced pneumoencephalograms; we're not doing these much anymore."

Scanning, as Dieter Schellinger, a director of the ACTA scanners at Georgetown University Hospital, points out, takes only half an hour and can be conducted even while the patient is fully dressed. So it can be done on an outpatient basis.

Still other physicians are using their own ingenuity to extend scanners' diagnostic potential. Alfidi and his colleagues are using the body scanner to help measure the density of bone without taking bone tissue from the patient for analysis. Knowing how much bone loss is occurring is important in the diagnosis and treatment of osteoporosis and arthritis. Alfidi and his co-workers have also developed a technique whereby they put needles into the area of the body found by the scan to be cancerous or abscessed and withdraw tissue for analysis. That way the patient can be biopsied on an outpatient basis and without the need for a general anesthesia.

However impressive all the uses to which the scanners are now being put, their potential has scarcely been tapped, radiologists concur. Schellinger and his team originally used the brain scanner only when they had a strong suspicion that a patient had an organic problem. Now they're using it on psychiatrically disturbed children and even on patients undergoing psychiatric treatment to see whether there might possibly be an organic basis for the patients' disturbances. "So the indications for this tool are getting larger and larger," Schellinger says.

As for the potential of the body scanners, "it looks as if they're going to be as important for the abdomen as the brain scanners are for the head," Lambie asserts. Alfidi anticipates that doctors will eventually be able to use the body scanners to examine specific areas of the heart in a patient who has had a heart attack. The scanners would visualize where the blood supply to certain areas of the heart have been cut off. Although scanner devices do not move quickly enough to "freeze" moving organs like the heart and lung—that is, catch them motionless —they will eventually be able do so, says G.M.K. Hughes, vice president of Pfizer Medical Systems, Inc.

As for the future of both the brain and body scanners in the next 5 or 10 years, Ledley predicts: "Every hospital will have one. It's going to become an ordinary X-ray device, and it will do every part of the body. It is going to give the physician increased capabilities in preventing some surgery. In many instances, I think, this is already beginning to be true." ☐