CT Scan—
Its Use and Abuse

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The concept of computerized transaxial tomography (CT scan) was first envisaged by both Oldendorf in America and Hounsfield in England. It was Hounsfield who produced the first marketable unit, with the backing of the English Musical Instrument Corporation (EMI), in 1971. This early unit was specifically designed for intracranial examination and, although cumbersome, proved to be an effective diagnostic tool. Then, in 1975, machines capable of scanning the entire body were developed. Since that time, CT scanner manufacturers have proliferated—at a recent meeting of the Radiological Society of North America, some 20 different brands were exhibited—and rapid technological improvements have rendered the CT unit an unparalleled diagnostic instrument. Using the CT machine, we are now able to accurately locate a disease process anywhere in the body, determine the nature of the process (cystic, solid or inflammatory) and ascertain its extent, including any involvement with adjacent organs. The CT scan is infinitely more sensitive than many other tests, and the type of information gleaned is invaluable in the diagnostic workup of patients. Surgeons, for example, have benefited enormously from the information provided preoperatively by the CT scanner. Ultimately, of course—and this should be our primary interest—it is the patient who gains from such diagnostic advances. Unlike many elaborate diagnostic procedures, the scan can be performed on an outpatient basis. Further, it is noninvasive and therefore entails minimal trauma and risk for the patient.

Diagnosis, however, is not the only application of the CT scanner—it greatest effectiveness may well be in its use as a treatment tool for patients with cancer. In radiation therapy, pretreatment planning and posttreatment evaluations are being increasingly determined by CT scans. Similarly, the scan is being incorporated into chemotherapy protocols, both for baseline and follow-up assessments.

Clearly, we have not yet explored all the possible uses of the CT scanner. In addition to performing routine case exami-
notations, we must carry out extensive research in order to realize the potentials and determine the limits of CT use.

Present Uses

Current applications of the CT scan are numerous; in some cases it has replaced long-used, standard procedures. Certain applications remain controversial, however, and one can only seek guidelines and attempt to benefit from others' experiences.

CT examination of the head has been possible long enough that we can compare it to other diagnostic modalities. Based on our experience, it would seem that routine screening of patients with headaches is not indicated. However, since the introduction of the scan there has been a dramatic diminution in the number of arteriograms and pneumoencephalograms performed at most institutions, and this is a very positive development, as these tests are expensive, time-consuming and highly unpleasant for the patients. Certain other examinations, such as skull X-rays and nuclide brain scans, have also been replaced, to a large extent, by CT scans.

Generally, abdominal exploration should include standard, routine examinations—upper GI series, barium enema and I.V.P.—before CT scanning.

In the chest, routine PA and lateral views or stereo films, decubitus views and overpenetrated films should be obtained before CT scanning is ordered. In some medical centers chest tomography has been replaced by CT scanning, based on the opinion that scans are more sensitive.

Within the thorax, the CT scan can accurately localize and delineate mediastinal, pleural and parenchymal tumors, and for examination of osseous or parossseus soft tissue masses, the CT scan remains the test of choice. However, many centers use both ultrasonography and CT scanning in such cases, as they are complementary procedures.

Though a helpful adjunct, the CT scan has by no means eliminated explorative surgery, despite some claims to this effect. In fact, speaking generally, most invasive techniques—such as angiography—have not been replaced by CT scanning, since the different methods provide different sorts of information.

A discussion of contemporary diagnostic techniques cannot ignore ultrasonography; significant technological advances have made it a diagnostic modality of utmost importance. Indeed, it is even

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CT Policy Criteria

With the large selection of diagnostic tests available, it is clear that this aspect of medical practice must be considered in physician education. Careful screening, by radiologists, of requisitions for CT scanings are of primary importance, in order to eliminate unnecessary examinations. The scanner is not a diagnostic panacea and it must be used with intelligence and restraint.

In establishing diagnostic justification for CT scans, other considerations also enter into the decision. One such consideration is time. Since the body scanner was first introduced, some two-and-a-half years ago, immense technological improvements have been made. Prototype models, although unquestionably a technological breakthrough, provided images
that can be likened to Dr. Roentgen's early attempts. In addition, the early models required between two and four minutes to render an image of each slice. This time has been considerably reduced and a better image can now be obtained in two to five seconds. However, it must be remembered that a considerable amount of time is usually expended positioning the patients on the table and injecting them with contrast material. Thus, even with the improved scanning time, studies may take 10 to 20 minutes for each patient, as many examinations require evaluation before and after the injection of contrast material. In addition, reproduction of the image on the screen may take an appreciable amount of time, and this in itself can reduce the daily quota of patients.

Another important factor is patient cost. Though fees charged for CT scanning have been reduced during the last year, the cost to the patient—$100 to $400—remains high, relative to most other diagnostic tests. Some centers have separate charges for examinations with and without the use of contrast material, and patients must pay the double rate if both examinations are performed.

The amount of radiation delivered during a CT scan is an aspect which has provoked little comment. The older, slower units deliver a dose of approximately two rads per slice, which is in the range of acceptability, but the newer models deliver a significantly larger amount of radiation to the patient. In an age in which we are all sensitive to the amount of radiation exposure patients receive, we must make a hard appraisal of our present practices. It would seem appropriate for medical physics departments to play a dominant role in this matter and compare the doses incurred by various machines currently on the market. Most patients undergo examination only once; however, repeated examinations of the brain over a prolonged period of time can result in damage to the cornea, and it is the responsibility of the radiologists to see that this sort of trauma does not occur. Future development entails reduction of the amount of radiation while preserving the quality of the image.

In sum, the criteria for formulating policy regarding CT scans are diagnostic reliability and superiority over other techniques, time and cost considerations, and the safety and well-being of the patient.

**Governmental Regulation**

In reality, CT policy is affected by developments that have little to do with real needs.

Distribution of CT scanners is a major problem currently facing the medical community. The scanner unfortunately made its appearance just at a time when rising medical costs had caught the attention of federal agencies; the scanner itself was blamed for the increase in health care costs, though this assertion actually has no merit. The federal government none-

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theless felt compelled to involve itself in CT planning policy, and the certificate of need concept, making all equipment purchases over $100,000 subject to federal approval, grew out of these economic concerns. To further complicate the situation, recent HEW recommendations suggest that before a hospital can acquire a CT scan, neighboring units must conduct 4,000 examinations per year. Again, this is not founded upon a realistic assessment, as no CT unit can accommodate this many examinations. While the basic intent of
these federal regulations is to prevent duplication of services and ensure adequate backup in terms of facilities and personnel, this sort of legislated distribution applies more logically to treatment modalities than to diagnostic techniques—and the scanner is primarily a diagnostic tool. The unfortunate result of this governmental interference is a battle over the control of scanning equipment and, particularly where head units are concerned, a source of conflict between radiologists and neurologists. Another potential problem related to government involvement is the complete loss of quality control—for example, making CT units available to untrained practitioners and encouraging mistakes and unnecessary examinations by inciting centers to perform more scans than good policy would dictate. Further, government-imposed restrictions on purchases will depress the market and obviate research incentives among manufacturers.

**Hospital Expense**

The cost of CT scanning units is very high, with prices ranging up to $750,000 for the newest and most sophisticated units. It is hoped that over the years prices will be reduced, although this has not been the case with other types of X-ray equipment, where prices have steadily increased. Ohio Nuclear recently marketed a dedicated head scanner at $95,000, presumably to circumvent the certificate of need stipulation. The drawback to this otherwise commendable unit is that it can accommodate only a relatively small number of patients. Most medical centers have managed to scrape together the necessary funds for a CT unit, recognizing it as a diagnostic necessity, though no one views such a purchase lightly.

The cost of maintaining a scanner is extraordinarily high (at our institution it runs to $300,000 per year); the claim that scanners are money-making devices is patently false. This maintenance figure includes various elements:

- **Salaries for medical, technical and secretarial assistance**—we have found it necessary to have two technicians on hand at all times that the machine is being used, and a physician is required to monitor the tests and inject contrast material.
- **Space requirements**—these are considerable, as the equipment is bulky.
- **Depreciation of the equipment.**
- **Utilities**—the system houses its own air conditioner.
- **Servicing costs.**
- **Charges for contrast material, syringes and other supplies.**

The impulse at many centers is to maximally utilize such a marvelous and costly piece of equipment. However, running a scanner on a 24-hour basis only serves to magnify the costs involved—and these costs are ultimately passed to the patient.

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—by the requirement for several teams of physicians and technicians and inevitable overtime payments. Examinations conducted at odd hours are inconvenient for patients, and especially so for outpatients who may travel long distances to obtain the test. In addition, it is apparent that excessive use of CT equipment induces an increase in breakdown time.

**The Task of the Future**

In the CT scanner we have a remarkable tool whose potential has hardly been approached. The medical and lay communities must act together in preventing this very important achievement of modern medicine from becoming a political football. Federal agencies are faced with solving the very pressing problem of increasing medical costs; we in the medical profession are faced with keeping bureaucratic intervention at a minimum. Above all, we cannot allow our accomplishments to go unused, nor our future to be subject to irrational restrictions.