# The Control Of Radiation Exposure From CT Scans

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**Abstract**

Computed tomography is a popular diagnostic tool in medicine. The widespread use of CT involves considerable radiation exposure to scan subjects. The radiation burden has come under increased scrutiny in recent years. The use of CT as a screening technique provides an additional dimension to the controversy. The article explores conflicting views with respect to radiation exposure from computed tomography. Recent advances in scan application and technology that offer scope for dose reduction are discussed.

## INTRODUCTION

Due to widespread use of computed tomography in medicine, the exposure to radiation from CT scans is an important issue.

Computed tomography has gained immense popularity as a diagnostic tool since its introduction in the seventies. However, the dose of ionizing radiation is higher than in most other methods of imaging. Despite the advent and development of MRI, a technique that is sophisticated and noninvasive without exposing the patient to radiation, the CT scan remains one of the most commonly performed procedures in diagnostic radiology. In practice, MRI often does not replace computed tomography even in situations when a substitution is appropriate and either modality could be used.

CT technology has made rapid strides in its scope of application ([1]), to the extent that it is not infrequently used as a screening device. More people are undergoing scans than ever before. In addition, companies are aggressively marketing the concept of full body CT scan screening to the public. Unfortunately, not all such enterprises make an effort to educate the consumer of the benefits and risks involved.

Therefore, the rapid advancement and utilization of computed tomography involves an increase in radiation exposure to the population and its associated risks ([2]). The problem has attracted the attention of scientists, health care professionals and patients. However, there is a lack of consensus on the subject of dose reduction and methods to achieve it.

Physicians (both radiologists and clinicians), technologists and manufacturers are involved at various stages in the decision-making process. CT technology has witnessed attempts to incorporate dose economy in design features. Radiation technologists must consider shielding techniques and selection of technical factors; physicians evaluate images in the clinical context. Other controversial topics that affect providers are the imposition of restrictions on referring physicians ordering CT scans, such as vetting by consultant radiologists, and the selection of non-ionizing radiation procedures. A policy of dose reduction thus entails multiple levels of intervention. The paper explores the viewpoints of different groups, possible strategies for intervention, their strengths and limitations, and the barriers to implementation.

There are several reasons for concern. As mentioned earlier, the volumes of computed tomographic scans are on the rise. Scanning protocols mandate inflated radiation doses. A combination of both factors contributes to more people getting exposed to more radiation. The trend reflects a shift in medical practices, as well as results of technological advances.

Traditionally, the physician has decided whether or not to scan a patient. Today, any individual can undergo a whole body scan without consulting a primary care provider. The health care profession, in general, has not sanctioned full body CT scan screening, but it has established a consumer base that cannot be ignored any longer. The concept appeals to “the worried well”, as is evident from the rapid proliferation of scan centers. The foremost argument in favor

of screening is its potential to save lives, and in some cases, this is probably true. Why, then, should it not be done?

## EVIDENCE AND LITERATURE

Computed tomography was introduced in the seventies and witnessed a rapid growth in popularity. It has remarkably versatile imaging applications that can be exploited for the diagnosis, and, in certain cases, other procedures to be conducted in a wide spectrum of pathological conditions. However, patients are exposed to radiation levels that are considerable, a common criticism of computed tomography.

Several articles comment on radiation exposure from CT scans. Trigaux and Lacrosse recognize that computed tomography is a diagnostic procedure that involves relatively high radiation doses ([3]). Crawley et al confirm that as a diagnostic imaging modality, CT gives higher patient radiation dose in comparison with other imaging modalities ([2]). In the UK, patient doses from radiological procedures were considerably reduced, but the efforts were largely offset by a corresponding rise in the collective dose from CT. A recent report from the Royal College of Radiologists in the United Kingdom acknowledges computed tomography as the single largest contributor to the collective dose from medical x-rays. ([4])

According to Seeram, patients are exposed to higher radiation levels from the use of computed tomography compared to most imaging techniques. There is a lack of awareness of the actual risks involved ([5]). The exposure to ionizing radiation in CT is emphasized in the CT versus MRI debate. MRI is safe. But MRI is more expensive and has limited availability. With health care costs already spiraling out of control, it is unlikely to supercede CT and the possible replacement has not occurred.

Therefore radiation exposure from computed tomography is still a matter of concern. The well known BMJ editorial by Rehani and Berry “Radiation doses in computed tomography. The increasing doses of radiation need to be controlled” published in the year 2000 is a discussion on the controversy ([1]). In the editorial, the authors point out the potential for increased radiation exposure from the advances in CT technology. Control of radiation burden is regarded as one of the parameters of quality control in computed tomography ([6]).

## THE ISSUE OF DOSE REDUCTION

Many providers do not believe that radiation exposure from CT scans present a significant health hazard. Admittedly, the effective doses, typically a few milliSieverts ([7], [8]) are well below the recommended limits for exposure. The NCRP set the upper limit of dose for any individual organ of 500 mSv (50rem), except the thyroid where the limit was set at 30 rem (300mSv). There is no consensus on whether any concerted action to reduce radiation needs to be taken at all. Recent controversy, both in peer-reviewed journals and in the media, is not based on any definite evidence with respect to actual radiation risks. In other words, no one has actually demonstrated the detrimental effects of radiation from CT scans. Consequently, a not insignificant number of physicians refuse to acknowledge the need for corrective action. Further, physicians and patients may hesitate to perform a CT scan when there is a reasonable indication for doing so, as possible fallout of the controversy. Such a trend is clearly undesirable due to an adverse effect on patient care.

However, as a result of the controversy, a sizeable number of physicians and scientists recognize that radiation exposure from computed tomography requires control. The more conservative approach advocates modification in the scope of application and CT technology.

According to Rehani and Berry ([1]), referring clinicians should keep in mind that CT examinations involve radiation risks and make requests where necessary and appropriate. This is the first challenge, for it means that the referring physician has to exercise a reasonable degree of caution. It may be difficult for clinicians who enjoy relative ease of referral to restrict CT examinations to cases with strong indications. While the approach is desirable in theory, it is difficult to implement in practice because of the issues involved. The most important issue that has to be resolved is how strong an indication must exist before a CT scan can be performed.

Other interventions seek to expand the radiologist‘s role in the referral process. The Royal College of Radiologists recommends that referrals for computed tomography should be vetted by an experienced radiologist ([4]). Crawley et al also encourage the rationalization of each examination by a consultant radiologist ([2]). The formulation of guidelines for referral facilitates the process. Radiologists are more likely to approve requests when guidelines form the basis for referrals ([9]).

Clinicians and radiologists together influence the selection of diagnostic tests. The utilization of alternate imaging modalities such as magnetic resonance imaging and

ultrasonography is to be encouraged. Magnetic resonance imaging is the preferred examination for the head, neck, and spine. MRI advances in gynecological imaging avoids radiation to the ovaries (the gonads are highly radiosensitive tissues).

Crawley et al discuss the critical importance of reducing patient doses from computed tomography ([2]). The authors describe reduction in collective effective doses by modifications in scan protocols. After radiologists reached a consensus on scanned volume, without diagnostic images falling short of quality criteria, technical factors were adjusted. Reductions in tube current and/or rotation time were studied, as well as alterations made to slice width and/or pitch. Manufacturers could invent and incorporate features that contribute to economy of dose. However, the acceptability of images from a clinical perspective requires further evaluation.

According to Dr. John F. Copeland (Director of Clinical Physics, Department of Radiology, Beth Israel Deaconess Medical Center, Harvard Medical School), “CT scanners should incorporate dynamic beam modulation in the future. An attempt should be made to avoid multiple scans”. He recommends further clinical studies of technical adjustments such as kVp, mAs, slice width and pitch.

Shielding of radiosensitive tissues, such as the gonads and breast in pelvic and thoracic examinations respectively, the eye and thyroid in head scans is another protective barrier. Hopper et al evaluated the ability of thin overlying bismuth radioprotective shielding to reduce the x-ray dose to radiosensitive superficial organs during diagnostic computed tomography (CT) They reported decreased radiation levels in the breast and similar results in other organs such as the eyes, thyroid and testes ([10]). The regular employment of shielding techniques during CT scans will require time, resources and expertise of trained personnel, and may impede implementation.

## ARE THE BENEFITS OF FULL BODY SCREENING WORTH THE RISKS AND COSTS?

The introduction of full body CT scans as a screening procedure for healthy, asymptomatic individuals adds a further dimension to the controversy. Such scan centers have mushroomed all over the country and their services are aggressively marketed to the public. Many companies nationwide now manufacture mobile CT (computerized tomography) units that go to several cities around the country, and offer CT scans in the locality of choice. A full body screening examination includes the chest, the abdomen, and pelvis. Although the radiation dose to the brain from a single CT scan is relatively low, the head is generally not included in full body scan.

A society that places a premium on health is concerned with preventive care, and receptive to the development of a mass screening procedure. The early detection of heart disease and tumors is regarded as a strong argument in favor of screening. An early diagnosis facilitates effective treatment and the outcome is a better prognosis for the patient.

Radiation exposure and cost are the main challenges still to be overcome. Though it is argued that only patients who need to be scanned at short, regular intervals are at real risk of over-exposure, radiation is still a threat because there is no research that establishes the long-term effects (or a lack thereof) after full body screening. The lack of conclusive evidence makes the procedure an unresolved issue. Its public health importance stems from the sheer numbers of people affected. Previously, the focus of the CT radiation controversy was patient exposure. However, the health care profession has to consider radiation exposure to potential scan subjects in the general population as full body CT screening is now a reality. The use of non-ionizing radiation technology was cited as a possible solution. Several scan centers offer MRI as an alternative to consumers concerned over radiation doses in CT. However, MRI is a far more expensive option. Further, mobile MRI scanners are very difficult to build and operate because of current constraints in the transport of huge magnets.

The chief criticism of screening, whether by CT or MRI is cost. The popular perception is that full body CT scanners are expensive commodities, and scans are a luxury that only the well off can afford. Full body CT scans are undoubtedly very expensive, and beyond the reach of most people. Their medical advisability has come under scrutiny on account of the vast sums of capital involved. A CT scan cannot be a substitute for regular screening and physical examinations. Scans are not recommended in men who are less than 45 years of age, or in post-menopausal women under the age of 50. Physicians are concerned that full body scans will highlight ill-defined abnormalities that require additional investigation. While full body CT scans are believed to be low risk, the follow-up procedures are not. The result may be significant expense, morbidity and even mortality.

Currently insurance companies are not inclined to pay for CT scans in healthy individuals. Their argument is that the

costs are too prohibitive, and the chances of finding significant abnormality too remote. The procedure is generally not covered by insurance, but the lack of coverage does not deter the thousands of consumers who pay anywhere between $750-1500 for a test that is believed to be the ultimate screening miracle. Screening a healthy population by scanning will yield few abnormalities, many of them non-specific, and the latter will require further workup. Therefore, it is doubtful if the benefits outweigh the risks of cost, radiation exposure and further testing ([11]).

## SUMMARY

The advances in computed tomography ensure that it remains a versatile, affordable and readily available diagnostic modality more than three decades after its introduction. CT scans enjoy a pride of place in diagnostic radiology that was challenged but not usurped by MRI. The radiation risk is a disadvantage inasmuch the procedure involves exposure to relatively high levels. The issue of radiation exposure is once more the focus of current debate.

It should be admitted at the outset that there is no conclusive evidence of radiation risk. Although radiation doses are considerable, the doses are still well below acceptable limits of exposure. Expert opinion is divided on whether the increase in radiation exposure from CT scans is a matter of concern or not. Moreover, there is no doubt that the benefits outweigh the risks when there is a strong indication for a CT scan. The key issue is that there must be a valid indication for a CT scan to be performed. While this may appear to be a relatively simple matter, it is actually difficult to ensure the judicious use of CT scans in practice. With the increased dependence of modern medicine on technology, coupled with the significant contribution that CT technology continues to make to medicine, it is difficult for health care providers to forego a quick, non-invasive diagnostic tool.

An increased number of physicians and scientists agree that concerted efforts are required in order to reduce radiation doses from computed tomography. The shielding of superficial radiosensitive tissues and the optimum selection of settings are some of the technical possibilities. Manufacturers of CT scanners are capable of significant contributions in the development of low dose technology. The evaluation of acceptability of low dose techniques from a clinical perspective remains a potential challenge. Therefore, most modifications have inherent disadvantages and barriers to implementation.

Finally, CT scans are now used as a screening procedure. The full body CT scan though restricted to those can afford it has a wide appeal. The commercial potential of full body CT screening makes it an attractive commodity, but the long term benefits and risks are not clear at this time. The cost-effectiveness and large scale benefit of full body scans are still to be established.

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