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DOSIMETRY AND RISK ANALYSES IN DIAGNOSTIC RADIOLOGY: COMPUTERIZED TOMOGRAPHY *

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The use of ionizing radiation for medical purposes is increasing every year. A very popular method recently added to diagnostic x-ray procedures is computerized tomography (CT), a radiological imaging method with high accuracy for the determination of the spatial distribution of x-ray attenuation in the region examined.

The asymmetric motion of the x-ray source (translation and rotation) in CT necessitates the use of rather different exposure measurement techniques than those used for conventional diagnostic x-ray sources. Patient skin dose varies considerably from region to region during a scan due to the motion of an x-ray source. The average skin dose to the patient is generally used in evaluating exposure to the patient. This can be obtained by integrating the area under the exposure profile curve and then dividing by the interval (Figure 1.).

There are more than 25 different kinds of CT scanners, with a total of 2000 units currently used in hospitals and private clinics in the world. These units may be broadly classified into three groups in terms of the dose delivered in diagnostic use.The dose delivered to the skin may be as high as 0.21, 0.15,and 0.08 Gy for the first, second, and third generation scanners, respectively. The dose t the patient's isocenter is estimated to be 40 to 70% of the surface skin dose. The doses used for calculations in this study were 0.13, 0.10, and 0.05 Gy for the first, second, and third generation scanners,respectively. These values approximate doses at the isocenter for a typical procedure involving both single and multiple scans.The multiple-scan to single-scan dose ratios for all scanners vary between 1.2 and 1.8 and average approximately 1.6.

Risk factors developed by the BEIR committee can be used to estimate the risk to the population due to the exposure incurred through medical radiography. In this paper, these risk factors are employed to obtain an estimate of risk due to radiation exposure from CT.

Estimates of the probability of premature fatal cancer due to typical CT procedures were made using an actuarial life table appoach. These estimates included the consideration that a potential victim of radiation-induced cancer may die from competing causes of death before the cancer develops or becomes fatal. Estimates of probability of

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premature death resulting from a CT procedure involving a second generation unit are shown in Figure 2. Curve A may represent an upper bound to risk estimates for a procedure involving any area of the body, since risk factors for breast, lung, GI tract, leukemia, and bone, as well as all other cancers were considered, assuming a dose of 0.10 Gy from second generation scanner to all organs. Curve B may be a lower bound estimate for a procedure involving the lung-breast area, since risk factors for leukemia, GI tract, bone and all other cancers were ignored, assuming dose of 0.10 Gy to breast and lung only. Curve C may be a lower bound estimate for a procedure involving the GI tract, since risk factors for lung, breast, leukemia, bone and all other cancers were ignored, assuming dose of 0.10 Gy to GI tract only.

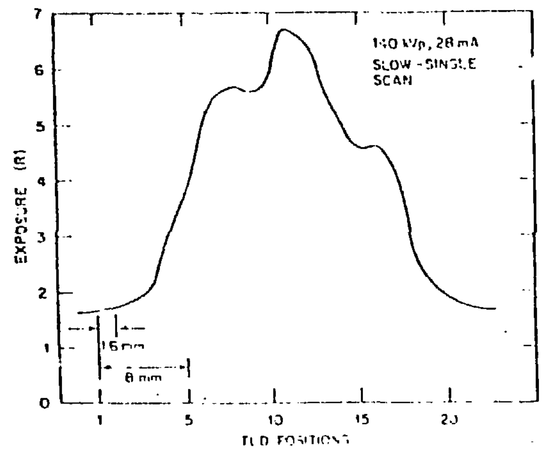

FIG. 1. A typical exposure profile after a slow single scan.

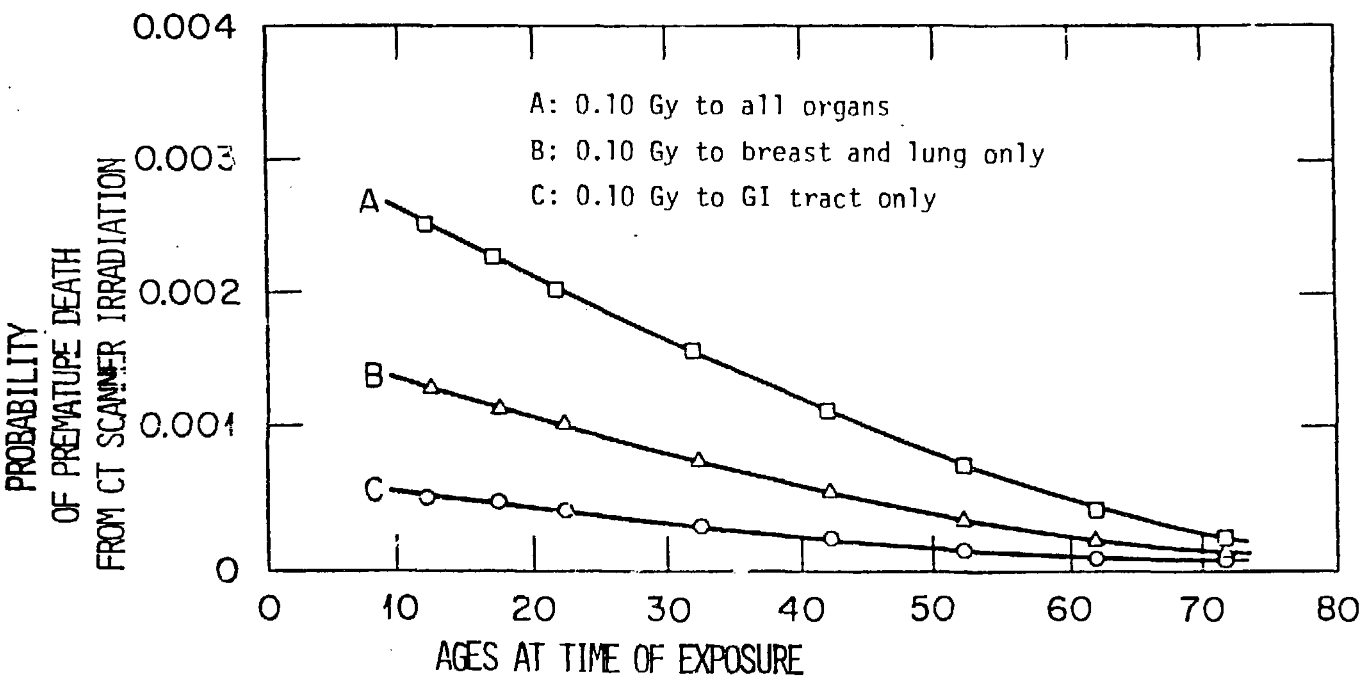

Figure 2: Estimates of probability of premature death from a single procedure involving a second-generation CT scanner.