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# Terms Used to Describe Radiation Dose From Medical Procedures

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Medical imaging procedures such as computed tomography (CT), fluoroscopy, and nuclear medicine involve the use of ionizing radiation. These imaging procedures are performed regularly at hospitals and clinics throughout the world and are an indispensable part of modern medical practice. The procedures allow clinicians to make critical diagnostic decisions, often with significantly lower risk than alternate procedures. However, the use of ionizing radiation does have some degree of risk.

As the science of medicine and information technology evolve, patients are being provided ready access to more of their medical information. Some documents include information about the radiation dose associated with the procedures to be performed. In addition, patients wanting to be more involved with their medical care are requesting the radiation dose associated with the procedure. This dose can be articulated in several ways, including common summary metrics such as CT Dose Index (CTDI) and Dose Length Product (DLP), which can be used to estimate the dose to a patient.

## What is radiation dose?

"Radiation dose" is a generic term. There are numerous ways to describe radiation dose. Three relevant to understanding radiation doses from CT procedures are absorbed dose, equivalent dose, and effective dose.

*Absorbed dose* is the amount of radiation energy absorbed by a material per unit mass of the material. The material could be a steel capsule or living tissue. Gray (Gy) is a unit used to describe absorbed dose. A gray is a joule of energy absorbed in a kilogram of material. A milligray or mGy is 1/1,000th of a gray.

Certain types of radiation can cause more biological damage than others for the same absorbed dose. A multiplier is used to account for this difference. The multiplier is applied to the absorbed dose. The resulting new dose is called the *equivalent dose* (or dose equivalent). Sievert (Sv) is a unit used to describe equivalent dose. A millisievert or mSv is 1/1000th of a sievert. For x rays and gamma rays, the multiplier is 1. So when talking about x rays, 1 mGy of absorbed dose equals 1 mSv of equivalent dose.

If each organ and tissue in the body always received the same equivalent dose or if each organ and tissue were equally sensitive to radiation, then we could stop there. But neither is the case. Certain organs and tissues are more sensitive than others. To take this into account, a risk factor is assigned to each organ/tissue. The equivalent dose for each organ or tissue is multiplied by the risk factor for the associated organ/tissue. The results are all added together and the sum is the *effective dose*. Effective dose is also measured in sieverts or millisieverts. (Yes, millisievert is used for two different quantities, which can lead to confusion.)

Since some organs and tissues get less radiation during a diagnostic imaging procedure, the effective dose will always be less than the equivalent dose and the absorbed dose. For all values to be equal, the whole body would need to be uniformly exposed to the radiation, and this almost never occurs in medicine.

## What is $CTDI_{vol}$?

$CTDI_{vol}$ is a specific measurement acquired for a CT procedure and is the volume weighted Computed Tomography Dose Index. It **i**s the absorbed dose (described above) measured at specific locations in an acrylic phantom. The measurements are made by a medical or health physicist and the data is entered into the CT scanner's computer. It is important to note $CTDI_{vol}$ is not a dose to any person.

## What is Dose Length Product (DLP)?

Dose Length Product or DLP is another value calculated for CT scans and is the $CTDI_{vol}$ multiplied by the length of the scan. The units are mGy centimeters (mGy cm). The DLP can be used to estimate effective dose from a CT scan.

## Is there a difference in the radiation risk for different organs?

Yes, some organs are more sensitive to radiation than others. To account for that, each organ or tissue is given a risk factor, called the tissue weighting factor. The risk (or tissue weighting) factor is used when calculating effective dose. Effective dose is one radiation dose that considers all the risk factors.

The International Commission on Radiation Protection (ICRP) lists tissue weighting factors in Table 3, page 65, of Publication 103 (ICRP 2007). Individual tissue weighting factor values range from 0.01 to 0.12.

## Are doses additive?

Effective dose can be added. Absorbed doses or equivalent doses can only be added if the exposure is to the same area.

## References

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## Resources for more information

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