Radiation dose to the patient

This article was checked by pedagogue

This article was checked by pedagogue, but later was changed.

ALTHOUGH CORRECT STILL TOO GENERAL REALLY. THIS TOPIC WAS ABOUT DOSES ABOUT GAMMA RADIATION IN MEDICINE - AS DISCUSSED YOU SHOULD HAVE INCLUDED PATIENT DOSES IN NUCLEAR MEDICINE NOT CT.

Introduction

In nuclear medicine gamma emitting radioisotopes (radiopharmaceuticals) are used to retrieve patient information by medical imaging when determining diagnosis. Radiation dose is measured in many ways dependent on different factors that have to be taken into account because of the risk of damage, both acute and long-term, caused to the patient by exposing them to any dose of radiation.

Importance in clinical medicine

By imaging the body's metabolic functions with a radiopharmaceutical, nuclear medicine is not only much more detailed but also less harmful since small doses are used. Although the patient feels no pain from radiation, any dose may expose the patient to risk of e.g. cancer induction. The goal for physicians is to find an optimal dose to the patient. The optimal dose is the smallest amount of radiation given to the patient that still provides the best possible image to determine the right diagnosis. When the risk of hurting the patient is greater than contributing to diagnosis determination the physician must consider different techniques. The radiation dose must never do more harm than help.

Radiation dose

The amount of radiopharmaceutical given to patients depends on the organs chemical properties and what type of dysfunction the patient is suffering from. Parameters such as the radiopharmaceuticals distribution, interaction and rate of decay in the body must be taken into consideration. The right amount of gamma rays must be emitted for detection as well as the imaging must be done before the radio-nucleotide decays and leaves the patients body.

The units

Absorbed dose, D_T, has the unit Gray (Gy). This measures how much radiation that is required for 1 Joule to be absorbed by 1 kg of matter. However this is a physical quantity. For the impact of ionizing radiation biological tissue we need another unit which is called equivalent dose, H_T, measured in Sievert (Sv). This is derived by multiplying the absorbed dose, D_T, with a radiation weighing factor, W_R, based on the type of radiation (particles do different amount of damage when absorbed).

D_T x W_R = Equivalent dose, HT

All tissues are not equally radiosensitive. The sensitivity is related to rate of cell-division, e.g. bone marrow and skin is very sensitive to low doses while bones and mature cartilage is not. By using a tissue weighing factor W_T, based on each tissues radiation-sensitivity we derive the effective dose, also measured in Sievert.

W_T x H_T = Effective dose, E

Effective dose, is for estimating the general long-term "over-all" effect on the whole body. This is only a calculated unit giving the probability/risk of long term effects patients might suffer, e.g. risk of secondary cancer or genetic damage.

Table of examination examples

(For reference: Amount of background –radiation individuals are exposed to is 3 mSv/Year.)

Description
Effective Doses for Adults from Various Nuclear Medicine Examinations.

Tc-99 and Flourine-18 are the most common radioisotopes used for diagnostic purposes. The unit Becquerel is used, expressed in MBq, as a measurement of the radioactive isotope decay.

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Source

Examination*	Effective Dose (mSv)	Administered Activity (MBq)†	Effective Dose (mSv/MBq)‡
Brain (^{99m}Tc-HMPAO–exametazime)	6.9	740	0.0093
Brain (^{99m}Tc-ECD–Neurolite)	5.7	740	0.0077
Brain (^{18}F-FDG)	14.1	740	0.019
Thyroid scan (sodium iodine 123)	1.9	25	0.075 (15% uptake)
Thyroid scan (^{99m}Tc-pertechnetate)	4.8	370	0.013
Parathyroid scan (^{99m}Tc-sestamibi)	6.7	740	0.009
Cardiac stress-rest test (thallium 201 chloride)	40.7	185	0.22
Cardiac rest-stress test (^{99m}Tc-sestamibi 1-day protocol)	9.4	1100	0.0085 (0.0079 stress, 0.0090 rest)
Cardiac rest-stress test (^{99m}Tc-sestamibi 2-day protocol)	12.8	1500	0.0085 (0.0079 stress, 0.0090 rest)
Cardiac rest-stress test (Tc-tetrofosmin)	11.4	1500	0.0076
Cardiac ventriculography (^{99m}Tc-labeled red blood cells)	7.8	1110	0.007
Cardiac (^{18}F-FDG)	14.1	740	0.019
Lung perfusion (^{99m}Tc-MAA)	2.0	185	0.011
Lung ventilation (xenon 133)	0.5	740	0.00074
Lung ventilation (^{99m}Tc-DTPA)	0.2	1300 (40 actually inhaled)	0.0049
Liver-spleen (^{99m}Tc–sulfur colloid)	2.1	222	0.0094
Biliary tract (^{99m}Tc-disofenin)	3.1	185	0.017
Gastrointestinal bleeding (^{99m}Tc-labeled red blood cells)	7.8	1110	0.007
Gastrointestinal emptying (^{99m}Tc-labeled solids)	0.4	14.8	0.024
Renal (^{99m}Tc-DTPA)	1.8	370	0.0049
Renal (^{99m}Tc-MAG3)	2.6	370	0.007
Renal (^{99m}Tc-DMSA)	3.3	370	0.0088
Renal (^{99m}Tc-glucoheptonate)	2.0	370	0.0054
Bone (^{99m}Tc-MDP)	6.3	1110	0.0057
Gallium 67 citrate	15	150	0.100
Pentreotide (^{111}In)	12	222	0.054
White blood cells (^{99m}Tc)	8.1	740	0.011
White blood cells (^{111}In)	6.7	18.5	0.360
Tumor (^{18}F-FDG)	14.1	740	0.019

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Licensing

Conclusion.

The challenge is to find the optimal dose for each patient. Nuclear medicine provides the most harmless imaging technique for patients today. However radiation is still harmful and all parameters must be weighed in by physicians before a procedure and dose is determined to assure the patients the best possible and most harmless care.

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