Radiation and Pregnancy

General

Special attention must be paid to the pregnant, potentially pregnant, or breast-feeding patient. The developing embryo or fetus is particularly sensitive to radiation. If an examination that involves radiation exposure can be postponed or replaced with another study, this is always desirable. If the study is needed, precautions to eliminate or reduce the dose to the embryo/fetus should be followed. Women of childbearing years should be given a pregnancy test before any therapeutic study involving radiation. Breast-feeding patients are of concern in nuclear medicine studies (diagnostic or therapeutic) because the compounds given to the mother may be taken up and excreted into the breast milk, and possibly ingested by a nursing infant.

Talking points

The likelihood of *not* developing childhood cancer is 99.93 percent; with a 5 rem (50 mSv) dose it is 99.12 percent. With a 5 rem dose, the increased likelihood is negligible (Wagner 1997).

The risk of abnormality is considered to be negligible at 5 rem (50 mSv) or less when compared to other risks of pregnancy, and the risk of malformation is increased only at levels above 15 rem (150 mSv). Exposure of the fetus to radiation arising from diagnostic procedures would rarely be cause for terminating pregnancy (NCRP 1977).

Exposure to less than 5 rem (50 mSv) has not been associated with an increase in fetal anomalies or pregnancy loss (American College of Obstetricians 2004).

The general population's total risk of spontaneous abortion, major malformation, mental retardation, and childhood malignancy is about 28.6 percent. A dose of 5 rem (50 mSv) increases this by about 0.17 percent (Brent 1999).

General diagnostic x-ray exposure during pregnancy should be avoided when possible. Doses from these procedures, however, are not high enough to warrant concern (American College of Radiology 2004).

There should be no concern about radiation exposure below 15 rem (150 mSv) to a pregnant patient (Wagner 1997).

High radiation exposure causes an "all or none" effect during the first eight days of pregnancy. This means that the dose of radiation the embryo receives either causes a spontaneous abortion or does nothing. Radiation doses received from a diagnostic medical imaging procedure are not high enough to cause a spontaneous abortion.

Values of radiation dose to the embryo/fetus from various medical imaging procedures.
It is important to note that these are only *typical* values. Actual absorbed dose will change depending on a number of variables, including the specific machine and manufacturer (in the case of radiology), study techniques (in the case of radiology on the settings of the machine used to produce the radiation, in nuclear medicine on the amount of activity administered and the patient's metabolism), and other issues.

Nuclear Medical Scan	Activity, mCi (MBq)	Radiopharmaceutical	Early pregnancy fetal dose, mrem (mSv)
Bone	20 (740)	^{99m}Tc MDP	460 (4.6)
Lung Perfusion	5.5 (200)	^{99m}Tc MAA	56 (0.56)
Thyroid	0.8 (30)	^{123}I NaI	60 (0.6)
Tumor	5 (190)	^{67}Ga Citrate	1,800 (18)
Lung Ventilation	30 (1,100)	^{133}Xe	0.54 (0.0054)
Heart	1.5 (55)	^{201}Tl Chloride	530 (5.3)
Kidney	20 (740)	^{99m}Tc MAG3	1,400 (14)
Heart	30 (1,100)	^{99m}Tc Sestimibi	1,700 (17)
Liver	9.5 (350)	^{99m}Tc Disofenin/ Mebrofenin	600 (6)
Kidney	20 (740)	^{99m}Tc DTPA	900 (9)
Infection	5.4 (200)	^{99m}Tc White Blood Cells	76 (0.76)
Liver/Spleen	8 (300)	^{99m}Tc Sulfur Colloid	54 (0.54)
Bone	20 (740)	^{99m}Tc HDP	390 (3.9)
Thyroid*	0.015 (0.55)	^{131}I NaI	4 (0.04)
Brain/Thyroid	30 (1,100)	^{99m}Tc Pertechnetate	1,200 (12)
Infection	0.5 (20)	^{111}In White Blood Cells	260 (2.6)
Heart/Blood Flow	25 (930)	^{99m}Tc Red Blood Cells	600 (6.0)

Information in table adapted from Russell 1997.
* This is for diagnostic use of ^{131}I for thyroid scanning. ^{131}I is widely used for therapy of hyperthyroidism and thyroid cancer. Its use is generally contraindicated in pregnancy, as large doses to the fetus and fetal thyroid may result.

Estimated radiation dose for 0, 3, 6, and 9 months gestational age based upon "typical" exposures.

	Fetal Dose in mrem (mSv)			
Study	**Early Pregnancy**	**3 Month**	**6 Month**	**9 Month**
AP Pelvis	144 (1.44)	131 (1.31)	127 (1.27)	157 (1.57)
PA Pelvis	40 (0.40)	1,600 (16)	232 (2.32)	100 (1.00)
Lateral Pelvis	53 (0.53)	32 (0.32)	48 (0.48)	52 (0.52)
AP T-Spine (wide FOV)	1.8 (0.018)	1.1 (0.011)	6.9 (0.069)	13 (0.13)
AP T-Spine (narrow)	1.2 (0.012)	0.8 (0.008)	4.6 (0.046)	8.9 (0.089)
Lateral T-Spine	0.6 (0.006)	0.6 (0.006)	1.7 (0.017)	3.2 (0.032)
AP Lumbar Spine	225 (2.25)	197 (1.97)	394 (3.94)	926 (9.26)
Lateral Lumbar Spine	113 (1.13)	62 (0.62)	84 (0.84)	85 (0.85)

Table of recommendations for radiopharmaceuticals excreted in the breast milk (Stabin 2000).

Radiopharmaceutical	Administered Activity, mCi (MBq)	Counseling?*	Advisory
^{67}Ga Citrate	5.0 (185)	Yes	Cessation
^{99m}Tc DTPA	20 (740)	No	None
^{99m}Tc MAA	4 (148)	Yes	Stop for 12 hr
^{99m}Tc Pertechnetate	30 (1,110)	Yes	Stop for 48 hr
^{131}I NaI	150 (5,550)	Yes	Cessation
^{51}Cr EDTA	0.05 (1.85)	No	None
^{99m}Tc DISIDA	8 (300)	No	None
^{99m}Tc Glucoheptonate	20 (740)	No	None
^{99m}Tc HAM	8 (300)	No	None
^{99m}Tc Sestimibi	30 (1,110)	No	None
^{99m}Tc MDP20 (740)	20 (740)	No	None
^{99m}Tc PYP20 (740)	20 (740)	No	None
^{99m}Tc RBCs in vivo	20 (740)	Yes	Stop for 12 hr
^{99m}Tc RBCs in vitro	20(740)	No	None
^{99m}Tc Sulfur Colloid	12 (444)	No	None
^{111}In WBCs	0.5 (18.5)	No	None
^{123}I NaI	0.4 (14.8)	Yes	Cessation**
^{123}I OIH	2 (74)	No	None
^{123}I mIBG	10 (370)	Yes	Stop for 48 hr
^{125}I OIH	0.01 (0.37)	No	None
^{131}I OIH	0.3 (11.1)	No	None
^{99m}Tc DTPA Aerosol	1 (37)	No	None
^{99m}Tc MAG3	10 (370)	No	None
^{99m}Tc WBCs	5 (185)	Yes	Stop for 48 hr
^{201}Tl	3 (111)	Yes	Stop for 96 hr

* "No" means that no interruption of breast-feeding need be suggested, given the criterion of a limit of 1 mSv effective dose to the infant and these amounts of administered activity. "Yes" means that some interruption is required, as noted in the next column.

** This requirement may be unduly restrictive, but was recommended because of documented cases in which significant levels of radioactive contaminants (^{124}I, ^{125}I, and others) were found in commercial products. If no contaminants are present, little or no interruption of breast-feeding may be necessary.

Other resources

Administration of contrast medium to pregnant or potentially pregnant patients: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual/AdministrationofContrastMediumtoPregnantorPotentiallyPregnantPatientsDoc4.aspx

References

American College of Obstetricians and Gynecologists. ACOG Opinion No. 299; 2004.

American College of Radiology. ACR Digest of Council Actions. Reston, VA: American College of Radiology; section II, 45H.1; 1994.

Brent RL. Utilization of developmental basic science principles in the evaluation of reproductive risks from pre- and postconception environmental radiation exposure. Teratology 59:182; 1999.

National Council on Radiation Protection and Measurements. Medical radiation exposure of pregnant and potentially pregnant women. Bethesda, MD: NCRP; NCRP Report No. 54; 1977.

Russell JR, Stabin MG, Sparks RB, Watson EE. Radiation absorbed dose to the embryo/fetus from radiopharmaceuticals. Health Phys 73:756-769; 1997.

Stabin MG, Breitz H. Breast milk excretion of radiopharmaceuticals: Mechanisms, findings, and radiation dosimetry. J Nuc Med 41:863-873; 2000.

Wagner LK, Lester RG, Saldana LR. Exposure of the pregnant patient to diagnostic radiations. Madison, WI: Medical Physics Publishing; 1997.

Glossary

becquerel: The becquerel (Bq) is the unit in the International System of Units to replace the curie (see curie).

curie: The curie (Ci) is the original term used to describe the amount of radioactive material present or strength of the source. It is based upon the radioactive decay rate of the radionuclide. One curie is equal to 3.7×10^{10} disintegrations (37 trillion decays) per second (dps); one becquerel is equal to 1 dps. The most common activity levels used in laboratories are the millicurie (mCi) and microcurie (μCi). A millicurie (mCi) is 1/1,000th of a curie and a microcurie (μCi) is 1/1,000,000th of a curie. In the International System of Units, the becquerel (Bq) describes the amount of radioactive material present. One curie is equal to 3.7×10^{9} Bq.

diagnostic: In medicine, diagnosis or diagnostics is the process of identifying a medical condition or disease by its signs and symptoms and from the results of various procedures. As used when referring to medical exams involving radiation, it is the use of x rays or radioactive materials to identify the medical condition.

dose: Dose is a general term used to express (quantify) how much radiation exposure something (a person or other material) has received. The exposure can subsequently be expressed in terms of the absorbed, equivalent, committed, and/or effective dose based on the amount of energy absorbed and in what tissues.

effective dose: Radiation exposures to the human body, whether from external or internal sources, can involve all or a portion of the body. The health effects of one unit of dose to the entire body are more harmful than the same dose to only a portion of the body, e.g., the hand or the foot. To enable radiation protection specialists to express partial-body exposures (and the accompanying doses) to portions of the body in terms of an equal dose to the whole body, the concept of effective dose was developed. Effective dose, then, is the dose to the whole body that carries with it the same risk as a higher dose to a portion of the body. As an example, 8 rem (80 mSv) to the lungs is roughly the same potential detriment as 1 rem (10 mSv) to the whole body based on this idea.

exposure: Exposure is commonly used to refer to being around a radiation source; e.g., if you have a chest x ray, you are exposed to radiation. By definition, exposure is a measure of the amount of ionizations produced in air by photon radiation.

high-level radiation: High-level radiation refers to radiation doses >10 rem to a human body.

low-level radiation: Low-level radiation refers to radiation doses <=10 rem to a human body.

observable health effect: An observable health effect is a change in physical health that can be detected medically. Observable health effects may include changes in blood cell counts, skin reddening, cataracts, etc. Whether or not it is an observable *harmful* health effect depends on whether damage to the body has occurred and whether that damage impairs how the body is able to function.

radiation: Radiation is a term commonly used to describe ionizing radiation (i.e., x and gamma rays, alpha and beta particles, neutrons). Ionizing radiation is radiation that is capable of producing ions by passing through matter.

radioactive material: Radioactive material is material that contains radioactivity and thus emits ionizing radiation. It may be material that contains natural radioactivity from the environment or a material that has been made radioactive (see radioactivity).

radioactivity: Radioactivity is the property of a nucleus in unstable atoms causing the atoms to spontaneously release energy in the form of photons (e.g., gamma rays) or subatomic particles (e.g., alpha or beta particles).
radionuclide: A radionuclide is a radioactive element, man-made or from natural sources, with a specific atomic weight.

rem: Rem is the term used to describe equivalent or effective radiation dose. In the International System of Units, the sievert (Sv) describes equivalent or effective radiation dose. One sievert is equal to 100 rem. One mrem is one thousandth of a rem.

risk: Risk is defined in most health-related fields as the probability or odds of incurring injury, disease, or death.

safe: Safe, as it is being used in the information on this Web site, is defined as an activity that is generally considered acceptable to us. This is not to say there is absolutely no risk with an activity that is considered safe; there may be a risk from the activity or the exposure to radiation, but it is the same or lower than the risks from everyday actions. At a level of radiation that is considered safe, an effect is either nonexistent or too small to observe.

sievert: Sievert (Sv) is the unit in the International System of Units to replace the rem (see rem).

therapeutic: Therapeutic describes the medical treatment of disease or disorders. With respect to radiation therapy, therapeutic doses (e.g., external beam treatments for tumors, radioiodine treatment for thyroid disorders) are significantly greater than those received from diagnostic procedures (e.g., chest x-rays, CT scans, nuclear medicine procedures, etc).