



## Pregnancy and Radiation Exposure

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The following information pertains to reproductive risks of radiation exposures to women who are pregnant and have questions about the risk of birth defects and miscarriage. It is also for men and women who are concerned about radiation exposures they have had that might impact the development of their sperm or their eggs (ova) and their risk of genetic diseases because of the radiation exposure. The next few paragraphs are some basic concepts as an introduction to help understand the more specific information provided later. It must be remembered, however, that every healthy woman without personal or a family history of reproductive or developmental problems begins her pregnancy with a 3 percent risk for birth defects and a 15 percent risk for miscarriage. These are background risks for all healthy pregnant women.

Ionizing radiation is the kind of electromagnetic radiation produced by x-ray machines, radioactive isotopes (radionuclides), and radiation therapy machines. There is potential for the embryo or fetus to be exposed during the diagnostic or therapeutic procedures for women who are pregnant and have x rays, fluoroscopy, or radiation therapy or are administered liquid radioactive materials. To determine the risks of a radiation exposure, it is best to request a consultation from a health physicist who works at or consults for the organization where the procedures were performed. In many instances, an evaluation of the radiation exposure would not be necessary because the radiological procedure did not expose the developing embryo.

Most diagnostic procedures expose the embryo to less than 50 mSv.<sup>1</sup> This level of radiation exposure will not increase reproductive risks (either birth defects or miscarriage). According to published information, the reported dose of radiation to result in an increased incidence of birth defects or miscarriage is above 200 mSv.

Another important consideration is the stage of pregnancy in which the radiation exposure occurred:

- In the first two weeks postconception or the second two weeks from the last menstrual period, the embryo is very resistant to the malforming effects of x rays. The embryo is, however, sensitive to the lethal effects of x rays, although doses much higher than 50 mSv are necessary to cause a miscarriage.
- From the third to the eighth week of pregnancy, the embryo is in the period of early embryonic

development but is not affected with either birth defects, pregnancy loss, or growth retardation unless the exposure is substantially above the 200 mSv exposure.

- From the eighth to the fifteenth week of pregnancy, the embryo or fetus is sensitive to the effects of radiation on the central nervous system. But here again, the exposure has to be very high. The threshold has been estimated to be higher than 300 mSv before an effect can be seen on the IQ of the developing embryo. General diagnostic studies do not reach these levels and, therefore, these effects are rarely of concern for patients.
- Beyond the 20<sup>th</sup> week of pregnancy, when the fetus is completely developed, it has become more resistant to the developmental effects of radiation. In fact, the fetus is probably no more vulnerable to many of the effects of radiation than the mother in the latter part of pregnancy. But the most important thing is that practically none of the diagnostic radiological procedures will affect an embryo at this late stage of pregnancy and certainly there is no risk for birth defects or miscarriage from the range of exposures that occur from diagnostic studies.
- The reproductive risk of nonionizing radiation, which includes electromagnetic fields emitted from computers, microwave communication systems, microwave ovens, power lines, cellular phones, household appliances, heating pads and warming blankets, airport screening devices for metal objects, and diagnostic levels of ultrasound, has been studied extensively. Two national committees of scientists evaluated the risk from these nonionizing radiation sources. Both of the committees published books on the subject. The first came out in 1993 from the Oak Ridge Associated University panel created by the White House while the second was the product of the committee of the National Academy of Sciences. Both of these groups concluded that the reproductive risk of nonionizing radiation is minimal if even existent.

### ***Radiation Exposure to the Embryo or Ovaries from Diagnostic X-Ray Studies***

When a diagnostic x-ray study is of the head, teeth, chest, arms, neck, or legs at a qualified facility, the radiation exposure is not to the embryo or ovaries. Scatter that might reach the embryo, if any, would be extremely small and would not represent an increased risk for birth defects or miscarriage. The most important issue is actual radiation dose received by the embryo. From diagnostic x-ray studies, the developing embryo would not receive a dose that would result in any measurable increased reproducible risk. This pertains only to exposure from diagnostic radiological studies including computerized tomography (CT) scans and fluoroscopy of the nonabdominal or pelvic areas.

Diagnostic x-ray studies that may involve direct radiation exposure of the developing embryo include (a) x rays of the back (lumbar spine) for evaluating a lower back pain or a nerve route pain, (b) intravenous pyelogram (IVP) to examine kidney function, (c) upper GI series for evaluation of gastrointestinal symptoms, (d) lower GI series (barium enema) to examine the structure and function of the large intestine,

(e) x-ray studies of bladder function, (f) x-ray studies of the gallbladder and gallbladder function, (g) x-ray studies of the structure and function of the uterus and tubes with the procedure known as a hysterosalpingogram (HSP), (h) x-ray studies of the pelvis and hips due to hip pain, and (i) standard abdominal x rays.

These studies may expose the embryo or the ovaries to radiation. However, the x-ray beam in the above-mentioned procedures may or may not be directed toward the embryo or ovaries. In some cases, the embryo may not be exposed at all, and for others the embryo or ovaries may be exposed for only a portion of the study. If a pregnant woman has had any of these procedures and has questions regarding radiation dose, the first step is to have the radiology department or a health physicist at the institution where the procedure(s) was performed determine the actual radiation dose received by the embryo or ovaries.

There are two important facts to consider when an evaluation is performed. First, the exposure in the vast majority of instances will be low and will not represent a reproductive risk for the embryo for birth defects or miscarriage. Second, regardless of the dose received from these procedures, each woman must realize that when she begins a pregnancy she has a reproductive risk (referred to as background risks) of 3 percent for major birth defects and 15 percent for miscarriage. These risks change depending on the family history of the mother and her own reproductive history.

### ***Radiation Exposure to the Embryo or Fetus from Diagnostic Nuclear Medicine***

Pregnant women may be administered radioactive materials for the treatment of various medical conditions while they are pregnant. Some of these radioactive materials may be administered before the patient knows that she is pregnant.

### ***Radiation Exposure to the Embryo or Fetus from Therapy Procedures that Do or Could Involve Exposure to the Abdomen***

One form of radiation therapy for cancer and other diseases is the administration (oral or by injection) of radioactive materials to treat various disease states. The most common of these is oral administration of radioactive iodine, which is used to treat hyperthyroidism or cancer of the thyroid. Another form of therapy, radioactive seeds, can be placed into various organs and tissues to treat cancer. And finally, radiation emitted from large machines (linear accelerators) can be used to treat cancer and other diseases. In nearly all instances, these uses of radiation will not occur when a woman is pregnant because the physician will be aware of the pregnancy and, therefore, take that into consideration before deciding to do these procedures. If the physician believes that delaying the procedure until the baby is born would be a significant risk to the mother, then s/he may decide to proceed and will share with you the possible risks of the radiation exposure to the unborn child.

Occasionally, radioactive iodine for the treatment of hyperthyroidism or cancer of the thyroid is administered to a woman who may not yet know she is pregnant. In these instances, it is essential that the exposure to the embryo or fetus be determined before any counseling can be provided. It is recommended that this determination be obtained from the health physicist, a nuclear medicine physician, or a radiation oncologist associated with the institution where the procedure took place.

Since radiation treatment for cancer involves quite high doses of radiation, it is very likely that the embryo will be affected if radiation therapy is initiated during pregnancy. In the early stages of pregnancy, embryo sensitivity is such that dosages of hundreds of rad per day of fractionated radiation therapy would not allow the embryo to survive. When exposures occur later in gestation, embryo sensitivity decreases but is still vulnerable to the cell-killing effects. Thus, there is still concern about radiation effects even though the embryo might survive.

It is possible that even with radiation therapy to other parts of the body, the embryo might receive an exposure that increases the risk of biological effects. Again, it is essential that the exposure to the embryo or fetus be determined before any counseling can be provided. It is recommended that this determination be obtained from the health physicist, a nuclear medicine physician, or a radiation oncologist associated with the institution where the procedure took place.

### ***Family Members or Friends Receiving External Beam Radiation Therapy***

It is commonly thought that after radiation therapy with a high-energy x-ray machine (a linear accelerator) the person who received the treatment may be "radioactive." This is not true. The radiation therapy does not cause the patient to become radioactive and be a source of radiation exposure. Therefore, contact with individuals receiving external radiation therapy does not have to be changed or limited.

### ***Family Members or Friends Administered Radioactive Materials for Diagnosis or Therapy***

If family members or friends have been administered radioactive materials for diagnosis or therapy, they will contain some residual radioactivity when they leave the facility. After a diagnostic procedure, they will be allowed to leave immediately unless there are other reasons for which they need to be hospitalized. In these cases, they have been administered a small amount of radioactive materials—only enough to successfully perform the procedure. There are no special concerns about interacting with them.

It might be different, however, if they have received radioactive material for a therapy procedure. In some cases, they might have to stay in the hospital for a few days because they received quite a bit of radioactivity. Even when they are allowed to go home, the amount of radioactivity they still have inside them will be much less but, most often, more than they would have with a diagnostic procedure. Depending on when the patient is allowed to leave and how much radioactivity was administered, there may or may not

be any special precautions. In cases where additional guidelines are needed, the patient is given instructions from their health care provider regarding extra precautions to be taken. Some of these precautions might include limiting time around children or someone who is pregnant. If you are a family member, you can discuss these directly with the physician. If friends underwent the procedure, they would have received the information so you can discuss your concerns with them.

### ***Radiation Exposure to the Sperm from Diagnostic X-Ray Studies***

There are no risks for genetic changes in the sperm if the testicle(s) has not been exposed. Testicular exposure and, therefore, sperm exposure may occur from some of the following diagnostic x-ray studies: (a) abdomen, hips, or pelvis, (b) lower spine, (c) bladder studies, intravenous pyelograms (IVPs), (d) fluoroscopy for urinary tract function, and (e) barium enemas (lower GI). Exposures to the sperm from these procedures are generally below 100 mSv.

The risk from radiation exposure of sperm prior to conception has been studied in two large populations. The concern by most patients is whether the radiation exposure to the sperm will result in birth defects. In one study, thousands of patients who were exposed to radiation in Hiroshima and Nagasaki and had families were studied for the incidence of genetic disease and other reproductive effects. After 50 years of studying this population, there has been no demonstrable increase in genetic disease. What was learned is that the risk is extremely small and that you need very large populations to demonstrate this risk. In other words, the risk from the radiation is too small to be detected amid the spontaneous incidence of mutations and the hereditary component of mutations that may affect the offspring.

Similarly, men exposed to radiation therapy and receiving large doses of radiation that may have exposed the testes as well as chemotherapy with drugs and chemicals, which are mutagenic, have been studied by the National Cancer Institute. There are now several thousand patients who have survived cancer that occurred in childhood, adolescence, or early adulthood. Families of these individuals also have not demonstrated an increase in birth defects or miscarriage.

It is possible that infertility or sterility may result if the testes receive high exposures of radiation. Because of the theoretical risks, we advise men who have had even diagnostic exposures to radiation to wait for at least two spermatogenesis cycles, which is about four months. While these very low exposures that occur from diagnostic radiological procedures are so low that there probably is not even a measurable risk, we still make this recommendation of waiting following the radiation exposure.

### ***Radiation Exposure to the Sperm from Radiation Therapy***

External beam radiation therapy of the pelvis, hip, femur (upper long bone of the leg), bladder, and prostate could involve radiation of the testes. While it is possible to shield the testes for some of these radiation

procedures, the scatter radiation could still be quite high. Unfortunately, with very high dosages to the testes the main complication is infertility. For those patients who remain fertile after therapy, their reproductive risks are not increased significantly. In other words, the risk of birth defects in the next generation for those men who remain fertile and conceive is quite low. Studies of the atomic bomb survivors indicate even in the high-exposure group that there is not an increased incidence of chromosome abnormalities or genetic disease in the next generation. That is also the case for studies from the National Cancer Institute, which indicate that patients who had cancer and received chemotherapy and radiation did not have an increased incidence in genetic disease or birth defects in the next generation, although they did have problems with infertility.

### ***Nonionizing Radiation Exposure from Communication Microwave Sources***

The sources of communication microwave radiation include microwave towers in neighborhoods used for communication devices by rescue squads, fire departments, and the police departments, for others who use emergency services, or just simply for cell phone connections in that area. These microwaves are nonionizing radiation and represent no risk for reproductive effects. They will not increase the risk of birth defects or miscarriage for individuals exposed to tower emissions or by living near the antenna for the emergency services in a community.

Other sources include buildings where there are a number of microwave dishes for transmission of communication and video. These dishes are receivers; they are not antennas. They emit no microwave radiation but receive microwaves either from satellites or antennas set up at distance places. They represent no risk whatsoever.

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<sup>1</sup>mSv is a unit of radiation absorbed dose and is an indication of the amount of energy absorbed in tissue.