RADIATION EXPOSURE

Radiation Poisoning, Radiation Sickness, Creeping Dose

A damage to body caused by a large dose of radiation.

⚠️ Risk factor ♂ Male & Female

About Radiation exposure

Exposure to various kinds and amounts of radiation can have lasting effects in humans. Radiation that is in the form of x-rays and gamma rays can be devastating to the sensitive cells of the human body, including germ and Leydig cells. The damage done depends on the age of the patient and dose, and ultimately can result in permanent sterility. Radiation exposition is caused by exposure to a large dose of ionizing radiation over a short period of time or long-term exposure to radon.

A causes of radiation sickness:

1. medical treatment that requires radiation - chemotherapy
2. accidental exposure to a high dosage of radiation - nuclear power plant accidents

The degree of hazard is determined by the concentration of the contaminants, the energy of the radiation being emitted, the type of radiation, and the proximity of the contamination to organs of the body. It is important to be clear that the contamination gives rise to the radiation hazard, and the terms "radiation" and "contamination" are not interchangeable.

High radiation dose gives rise to deterministic effects which reliably occur above a threshold, and their severity increases with dose. Deterministic effects are not necessarily more or less serious than stochastic effects; either can ultimately lead to a temporary nuisance or a fatality. Examples are: radiation burns, and/or rapid fatality through acute radiation syndrome, chronic radiation syndrome, and radiation-induced thyroiditis.

There is no specific treatment once radiation exposure has occurred. There are ways to help manage the symptoms while the body recovers from the damage already done. This can generally be helpful and supportive during the healing process.

Symptoms

- bleeding from nose, mouth, gums, rectum
- bloody stool
- confusion
- dehydration
- hair loss
- inflammation of exposed areas ulcers (mouth, esophagus, stomach, intestines)
- vomit blood
- reduced testicular size
- impaired spermatogenesis
- infertility

Associated diseases

- cancer
- lupus
- leukemia
• brain tumors
• rheumatoid arthritis
• multiple myeloma
• asthma
• Hodgkin’s disease
• Parkinson’s disease
• Alzheimer’s disease

Complications

Prodromal syndrome

The “prodromal syndrome” is not a diagnosis, but the technical term used by mental health professionals to describe a specific group of symptoms that may precede the onset of a mental illness. For example, a fever is “prodromal” to measles, which means that a fever may be a risk factor for developing this illness.

Bone marrow death

Bone marrow death is caused by a dose of radiation between 2 and 10 Gray and is characterized by the part of the bone marrow that makes the blood being broken down. Therefore production of red and white blood cells and platelets is stopped due to loss of the blood-making stem cells (4.5 Gray kills 95% of stem cells). The loss of platelets greatly increases the chance of fatal hemorrhage, while the lack of white blood cells causes infections; the fall in red blood cells is minimal, and only causes mild anemia.

Gastrointestinal death

Gastrointestinal death is caused by a dose of radiation between 10 and 50 Gray. Whole body doses cause damage to epithelial cells lining the gastrointestinal tract and this combined with the bone marrow damage is fatal. All symptoms become increasingly severe, causing exhaustion and emaciation in a few days and death within 7–14 days from loss of water and electrolytes.

Risk factors

• radiation exposure
• radiotherapy
• radioactive substances
• nuclear accidents

Prevention

• Avoid unnecessary exposure to radiation.
• Persons working in radiation hazard areas should wear badges to measure their exposure levels.
• Protective shields should always be placed over the parts of the body not being treated or studied during x-ray imaging tests or radiation therapy.

How it can affect fertility

Except for the bone marrow, the most sensitive organs to radiation therapy in the body are the gonads, both the male testis and the female ovary. The extent of damage in the female and male gonads depends on the dose, fractionation schedule and irradiation field. Radiation therapy can be administered as teletherapy, which aims at treating a large volume of tissue. For small volumes of tissue, such as in the case of cervix cancer in the female, radiation therapy can be administered in encapsulated sources of radiation that can be implanted directly into or adjacent to tumor tissue. Whenever female reproductive organs are involved in the irradiated field, i.e., the ovaries, the uterus and the vagina may be compromised and damaged by direct irradiation. Scattered radiation may also damage reproductive organs.

In the female, radiation therapy results in dose-related damage of the gonads by the destruction of primordial follicles, which constitute the nonrenewable follicle pool. In women, the degree and persistence of the damage is also influenced by age at the time of exposure to radiotherapy and due to a reduced reserve of primordial follicles in older women, the number of follicles remaining may be also be reduced at older ages. Table 1 presents a compilation of current knowledge on the impact of radiation doses and age at radiotherapy in male and female gonadal function. In general, a dose of about 2 Gy (Gray - a derived unit of ionizing radiation) applied to the gonadal area destroys up to 50% of the ovarian follicle reserve. In pediatric patients, failure in pubertal
development may be the first sign of gonadal failure in both sexes. Total body irradiation (TBI) given in conjunction with myeloablative conditioning prior to bone marrow transplantation is one of the most toxic treatments for the gonads and it is highly related to gonadal failure in both sexes.

**In men,** the gonadal stem cells responsible for the continual differentiation and production of mature spermatozoa, the spermatogoniae, are extremely sensitive to radiation. The Leydig cells, which are responsible for the hormonal production of testosterone, are on the contrary more resistant to radiotherapy and adult patients may thus preserve hormonal production although becoming infertile. In prepubertal boys, the sensitivity to radiation therapy of Leydig cells is greater than that of older males at very high doses. Prepubertal patients may retain Leydig cell function after radiation therapy during childhood and in those cases they will present with normal pubertal development and well-preserved sexual function later in life. Nevertheless, most of those patients present at adulthood with reduced testicular size, impaired spermatogenesis and infertility.

**Prognosis**

The radiation dose to the ovaries that generally causes permanent female infertility is 20.3 Gy (Gray - a derived unit of ionizing radiation) at birth, 18.4 Gy at 10 years, 16.5 Gy at 20 years and 14.3 Gy at 30 years. After total body irradiation, recovery of gonadal function occurs in 10–14% of cases, and the number of pregnancies observed after hematopoietic stem cell transplantation involving such procedure is lower than 2%.

Young patients who undergo chemoradiation might be interested in fertility preservation by the use of ovarian transposition, cryo-conservation of oocytes, ovarian tissue and freezing sperm through cryopreservation.

High doses of radiation during pregnancy induce anomalies, impaired growth and intellectual disability, and there may be an increased risk of childhood leukemia and other tumours in the offspring.

**Find more about related issues**

**Diagnoses**

**Non-obstructive azoospermia**
Complete absence of sperm in the ejaculate due to testicular failure.
Learn more at: [www.fertilitypedia.org/therapy/diag/non-obstructive-azoospermia](http://www.fertilitypedia.org/therapy/diag/non-obstructive-azoospermia)

**Oligoasthenoteratozoospermia**
Male fertility diagnosis defined as a combination of low sperm concentration, reduced motility and abnormal sperm morphology in the ejaculate.
Learn more at: [www.fertilitypedia.org/therapy/diag/oligoasthenoteratozoospermia](http://www.fertilitypedia.org/therapy/diag/oligoasthenoteratozoospermia)

**Premature ovarian failure**
The loss of function of the ovaries before age 40.
Learn more at: [www.fertilitypedia.org/therapy/diag/premature-ovarian-failure](http://www.fertilitypedia.org/therapy/diag/premature-ovarian-failure)

**Testicular failure**
The inability of the testicles to produce sperm or testosterone.
Learn more at: [www.fertilitypedia.org/therapy/diag/testicular-failure](http://www.fertilitypedia.org/therapy/diag/testicular-failure)

**Thyroid disorders**
A medical condition impairing the function of the thyroid.
Learn more at: [www.fertilitypedia.org/therapy/diag/thyroid-disorders](http://www.fertilitypedia.org/therapy/diag/thyroid-disorders)
Radiation - symptoms
Early symptoms of radiation sickness.

<table>
<thead>
<tr>
<th></th>
<th>Mild exposure</th>
<th>Moderate exposure</th>
<th>Severe exposure</th>
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</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nausea</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Vomiting</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fever</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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Later symptoms of radiation sickness:
- Stomach pains
- Coughing
- Profuse sweating
- Numbness, tingling in hands and feet, tremors, poor hearing, loss of taste
- Skin rash

Table 1 – High risk prolonged azoospermia in men or amenorrhea in women.
Radiotherapy protocols with high or intermediate impact on ovarian and testicular function.

<table>
<thead>
<tr>
<th>Time of onset</th>
<th>High risk prolonged azoospermia in men or amenorrhea in women</th>
</tr>
</thead>
<tbody>
<tr>
<td>3–6 months</td>
<td>Testicular radiation dose: 4–16 Gy in pre-pubertal boys (19,20)</td>
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<tr>
<td></td>
<td>Testicular radiation dose: 2–4 Gy in adult men (9,17)</td>
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<tr>
<td></td>
<td>Pelvic or whole abdominal radiation dose: 8–20 Gy in adult women (21,22,23)</td>
</tr>
<tr>
<td></td>
<td>Pelvic or whole abdominal radiation dose: 16–40 Gy in pre-pubertal girls (21,22,23)</td>
</tr>
</tbody>
</table>

Intermediate risk:
- Testicular radiation dose: 1–5 Gy from scattered pelvis or abdominal radiation (11,13,15)
- Pelvic or whole abdominal radiation dose: 5–10 Gy in pre-pubertal girls (21,24)
- Pelvic or whole abdominal radiation dose: 10–15 Gy in pre-pubertal girls (21,25,26)
- Cisplatin radiotherapy dose > 25 Gy (16)

Sources

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