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Effects of ionizing radiation on the human body

Patrycja Ręba

Jan Kochanowski University
Faculty of Medicine and Health Sciences

Admission

All living organisms on Earth are constantly pierces ionizing radiation. It's the kind of radiation that during the passage through mattergenerates ions having electric charge. Ionizing radiation occurring in its natural form can also be dangerous to the human body, and its large doses may even lead to death. Natural radiation is at all times present in the human environment, which is caused everywhere occurring radioisotopes of various elements in nature, and cosmic radiation. The level of influence of ionizing radiation on the body also depends on the size of the absorbed dose and the type of body tissue and the phase of the cells. Most promienioczułymi are reproductive cells, hematopoietic and lymphoid tissue. High radiosensitivity have also the deepest layer of the skin, the eye lens, the intestinal mucosa endothelia vessels, and cartilage cells and (osteoblasts) (1).

Goal

The aim of the study was to analyze the impact of ionizing radiation on the human body.

Material and methods

In order to obtain the necessary information has been analyzed information, data and reports on the impact of ionizing radiation on the human body.

Keywords: ionizing radiation, stochastic effects, deterministic effects

Results

There are many interpretations of ionizing radiationHowever, all capture and some of these same issues. Z. Jaworski says that ionizing radiation is the rightandthat each typewith radiation which induces ionization of the medium material, by which is meant separation of a minimum of themdnego electron from an atom ormolecule or killing it with the crystalline structure. Furthermore, the electromagnetic radiation is regarded as ionizing radiation, by which the photons have an energy greater than the energy of photons of visible light (2).

Ionizing radiation causes changes in electric charges in the neutral atoms and molecules of matter. The present type of radiation is a short electromagnetic radiation (X-rays or gamma rays), and any radiation consisting of particleWhich cause ionization direct or indirect. The particles are directly ionizing particles charged (Electron, proton) having sufficient energy to cause ionization of the atom by collision. ionizing particlesindirectly-binding particles are notcharged (neutron, photon) that can trigger the center ionizing particles or induce nuclear transformation (3).

Ionizing radiation, as well as radioactive materials or isotopes, etc. Mostly man associated negatively, in particular the risk for us and for the environment, in particular those negative feelings were reinforced by the failure of Chernobyl, as well as the result of fear of the use of nuclear weapons, problems with the storage of radioactive waste, etc. a necessary, therefore, is to emphasize that ionizing radiation is not only a threat. Modern man uses radiation in various fields, especially in industry, medicine, geology, archeology, art history, environmental protection and chemical analysis (4).

Ionizing radiation is widely used in medicine, especially in radiology. However, it should be emphasized that despite the fact that the radiation has many beneficial applications in medicine, this excess has a negative effect, because it may be the cause of many diseases and sometimes death of a man. In radiodiagnostic to reduce the radiation doses used more and more sensitive radiation detectors, minimizing the dose of radiation and the energy is used more efficiently software. In nuclear medicine, to reduce the radiation dose used isotopes with relatively short half-life. First of all isotopes of radioactive elements are used to diagnose diseases. Isotope ^{99}Tc is introduced into the human body in the form of a chemical compound, which then in the body is monitored, allowing to examine the accuracy of activities of the examined organs. After entering a given dose of radioactive isotopes, ionizing radiation impact on the human body from the outside or inside. The influence of external radiation is dependent on the insight. Ionizing radiation has particular application in interventional radiology and X-ray in diagnostics (5).

Although X-rays are considered to be harmful, it is often used during the so-called. X-ray images which are already fairly widely used method that allows to illustrate the internal structure of human organs. On the basis of X-rays can diagnose broken bones or identify lung diseases, eg. Pneumonia (6).

In contrast, radiation therapy, which is specialized in the fight against cancer cells, uses specialized equipment that accurately dispenses the proper dose radiation in the affected place. Are used for the purpose of X-ray cameras (more and less) electron accelerators (commonly used) or natural radioactive sources, for example. Iridium-192 or cobalt-60. They are also used radioactive isotopes such as cesium, iodine, phosphorus, as well as gold and tantalum (7).

Ionizing radiation has also found use in computed tomography (CT - called. *computed Tomography*), Which has its origin in the X-ray technology. It is quite modern diagnostic method that allows the analysis of each ply tissues, also determines oriented in the two-dimensional cross-sections of the human body with the distribution of approx. 0.5 mm. It should be emphasized that the dose of radiation administered during CT is higher (slightly) than conventional X-rays emitted when using X-ray, but it is much more accurate. CT is an

X-ray arbitrarily designated part of the body with a beam of X-rays and defining their absorption by the tissues of various densities. The information obtained is processed by a computer specialist giving the result of a two-dimensional, which presents in various shades of gray high-resolution image, which resembles a cross section of anatomy. Specialized software will also enable the creation of three-dimensional images of anatomical structures studied (8).

In view of the fact that the human body does not have organs, which would enable him to detect ionizing radiation, it was necessary to develop techniques which will allow to define doses that are administered to people at risk of not include because of their profession or as a result of accidental contact with the radiation. Dosimetry is a branch of nuclear physics (medical) which deals with the determination of the dose of ionizing radiation, to do this, it uses three basic types of doses, as follows:absorbed dose equivalent dose limit (9).

To identify abovetinsel doses used are various types of methods. The value of the dose can be calculated based on the type of source promieniotwórczego, activityAnd the time and distance are in a range of radiation. sent by the source. They can also be measured using various types of gauges, eg. Video radiochromowor e dosimetere thermoluminescent. For the assessment of dose in biological systems are also used various kinds of cytogenetic assays, which are used to evaluate (estimate) the radiation dose (10).

In the literature one can find the distribution of the effects of irradiation of ionizing distinguishing the effects of stochastic and deterministic. for the consequences Stochastic ionizing radiation is given to those, wherein instance is defined in a probability, that they may but need not occur. Mostly, it is assumed that the indicated probability depends exponentially from the resulting human dose. Among the effects of stochastic stands out above all cancers, but also hereditary changes in the offspring. It should be emphasized that this type of change, and in fact likelihood of their occurrence is extremely difficult, especially since, for example. Emergence of a cancer may be a significant delay and can result from various causes other than the received and measured in doses of ionizing radiation (11).

Stochastic effects can be divided into somatic and genetic. Somatic effects take place mainly in somatic cells, and include only one body. In contrast, genetic effects manifest themselves mostly in the germ cells and cause changes in successive generations. Somatic effects manifest themselves much later, it should be noted that the radiation does not kill the cells, but causes mutations in them. The key is called. radiation-induced cancer. Although the tumor formed in stages, but the first step is to make changes in one or more cells, which subsequently will be converted to, and grow into tumors that can be diagnosed. Tumors activated by ionizing radiation may be present in virtually every human tissue. Tumors of this type have a fairly long latency period, which depends on the age of the person irradiated. - 10 years), while the tumors of the brain, breast, lung, and thyroid have a latency period of from 20 to 30 years (11).

And the second type of effects of ionizing radiation or deterministicThey occur when a person receives a relatively large doses which may be a temporary or permanent tissue damage. It should be emphasized that in the case of exposure to very high doses of radiation can lead to so-called. radiation sickness, which may result in death. Type of deterministic effects occur at doses that exceed0.5 Gy (whole body) However, in some cases, this value may be much lower for individual bodies (12).

Deterministic effects are dose threshold below which the influence of the radiation is compensated for by a skin cell, and is clinically invisible. While above this threshold, the severity of symptoms increased with radiation dose. For most curve depending on the severity of the symptoms of the size of the dosagesigmoidal shape, and its slope depends on the individual sensitivity spreading (12).

Referring to the effects of ionizing radiation on the human body should be remembered that make up its organs, which themselves are composed of tissues, which in turn contain cell. At a deeper level, the organization should consider the action of radiation on individual molecules essential for biological processes. In the following, operation will be described the influence of ionizing radiation on selected components of the human body, in particular cells, tissues, organs and DNA (10, 11).

Cell energy transfer takes place by the interaction of the radialorbital electrons present and. In these processes is given by photon the whole or part of the energy (In the case of particles - formed by the action of the particle already has a different energy). The radiation energy may be sufficient to spowodować killing of electron orbit. It is a processionization: the radiation from which it took its name (13).

The impact of ionizing radiation on human cells can be twofold. The first type is the impact direct, which are characterized by particles of ionizing radiation having a relatively high value LET (ang. *Linear Energy Transfer*), That is the amount of energy, which is transferred by the particle radiation to the medium in which it moves (Eg. Cells, tissue) per unit length of the path of movement of the particle. This type of ionizing radiation consists of a direct ionization target atoms (eg. a DNA molecule) due to the Coulomb interaction, which consequently, can lead to damage to biological cells such as (14):

- DNA single strand break (ang. *Single Strand Break*, SSB);
- break two strands of DNA (called. *Double Strand Breaks* DSB);
- Damage single base;
- Damage nitrogen base;
- connect nitrogen bases on one strand of DNA (called. *Intrastrand Cross-Links*).

And the second type is an indirect influence on the cells, which involves the ionisation of other atoms or molecules to the creation of free radicals. The indirect impact is considered to be a fairly complex process, because it is composed of several stages. In the first step reacts with photon radiation that falls on the center, whereby the electron is emitted by a fairly high energy. Electronmoves in the hydrated tissue to give rise to the reactive oxygen species (RTF). Consequently, the free radicalsThey have an unpaired electron in the valence shell, which are highly reactive molecules. As a result, they are susceptible to breakage and hydrogen phosphodiester bonds in a DNA molecule (15).

According to the International Atomic Energy Agency the possible consequences that may occur as a result of irradiation of living cells are (16):

- lack of visible effects;
- the occurrence of significant delay in cell division;
- apoptosis;
- the occurrence of mutations, which may result in the emergence of new phenotypic traits or carcinogenesis;
- increased resistance to further doses of radiation.

It should be emphasized that the damage to the cells responsible not only ionizing radiation. In the body,Human each cell is formed every day about 106 spontaneous DNA damage, of which about 10% are double-stranded damage. These lesions are caused by aggressive freeradicals that are formed during metabolism. The body of every human being should be able to defend itself against damage. This type of defense system is based on the induction of gene expression and intra- and intercellular signals that trigger the production of enzymes repairing damage and other processes that enable the functioning of irradiated cells (17).

Decreased renal tissue or organ after irradiation depends on the life span of mature cells. If the period of their life is long, the function of tissues and organs can be preserved for a long time. However, if the period of their life is short, this function of tissues and organs weaken soon after irradiation, because the reproductive mechanism can not keep up the

supply of new cells. Tissues with a rapid series of playback of cells are damaged rapidly and undergo profound changes (is more promienioczułe) than tissue slow playback cell cycle and long-term life of mature cells (18).

Cancer cells (whose sole purpose is rapid multiplication, are in the solid phase division) after DNA damage (already mutated) are not able to go back to an earlier time (mutated - because that condition was random) because after a few divisions disappear. Normal cells (wild-type) where a barrier is not exceeded, are able to return to normal operation. The fact is that one may sufficeundamaged by radiation cancer cell to tumorigenesis began anew. Death of the cells occurs at the time of the division, the tissues that have rapid kinetics of renewal, for example. Intestinal mucosa, are much more sensitive than the tissue in which the cells shall divide less frequently, for example. Smooth muscle. Also tissue have many undifferentiated cells that dysonują significant proliferative potential are much more sensitive to radiation than is the case in a differentiated tissue (19).

Another factor determining the sensitivity of tissues to radiation is the construction of the tissue. Clinical studies have shown that tissue tolerance for radiation depends to a large extent on the volume of tissue which has undergone the influence of radiation. It is assumed that the tolerance of the tissue to radiation is dependent on the presence of sufficient quantities of mature cells, which are able to maintain the physiological function of the tissue (or organ). For example. Kidney or lung to maintain physiological function, it is only necessary approx. 30% of the non-irradiated tissue (20).

Taking into account the role of tissue and the effects of irradiation for the entire human body, one should mention the so-called. radiosensitive relative. Therefore, it introduced the so-called issue. critical organ, or organ damage caused by theradiation affects the patient's quality of life. For example, referring to X-rays and gamma, a critical organ is considered to bone marrow, gonads, and a lens of the eyeWhile taking into account isotope of iodine, such as organ is considered to thyroidAnd the adopted for oral alpha- - radioactive, such organ is intestinal mucosa (21).

Making human activities involving exposure the influence of ionizing radiation is in particular on (22):

- manufacture, processing, storage, as well as storage and transport or use of nuclear materials, sources, and radioactive waste and spent nuclear fuel, and Trading in them;
- construction, commissioning, trial and permanent operation and decommissioning of nuclear facilities;
- construction, use, and closing liquidation landfills radioactive and storage of spent nuclear fuel, as well as the construction and service storage facilities for spent nuclear fuel;
- production and use equipment with radioactive sources, as well as rotation of this type devices;
- laboratories and startup studio, in which work is based on the use of ionizing radiation sources, e.g.,. X-ray laboratories;
- dokładaniu radioactive substances during the manufacturing process the manufacture of products;
- administrationradioactive substances to man and animals for medical or veterinary purposes. To make the diagnosis, treatment and to research.

A license is required or notification in terms of safetyñState jandand drowego radiological protection.

radiation protection This is to prevent human exposure and environmental contamination, and in case of inability to prevent such situations - ograniczenie their effects da level as low as soon as is reasonably achievable, taking into account economic, social and health (23).

Conclusions

Ionizing radiation for centuries accompanied the man and other living organisms on Earth, and its intensity is several times higher in past geological periods. Therefore, people think about the statement that no radiation destroys life, it is likely that it contributed to the origin of life, and has become one of the main factors of evolution.

If modern humanity has not seen the benefits from the use of radioactive materials and radiation emitted by them, their production and use would be situated not justified. As evidenced currently undertaken by mankind activities, and especially the artificial production of radiation, can achieve great progress in both the treatment and medical diagnostics, and also contributed to a number of techniques in scientific research, agriculture and industry, which have improved living conditions ground.

Radiation, its pros and cons are now the most hot topic for many scientists and politicians. Therefore, there is no doubt that many people feel considerable anxiety, especially before their negative impact, in particular on its impact on human health and the health of future generations. Risk of accidents in nuclear facilities, management, transport and storage of nuclear waste, the effects of releases from nuclear power plants to the environment and nuclear weapons tests - all of these issues are discussed in books, newspapers, television reports and everyday conversation.

The effects of radiation are examined over a century. Nuclear physics is no longer a young science, and few risk factors were as well known as the risks associated with radiation. The international community, through organizations such as the International Commission on Radiological Protection (ICRP), United Nations Scientific Committee. Effects of Atomic Radiation (UNSCEAR) and the International Atomic Energy Agency (IAEA), has established strict rules for the limits of doses, uses of radiation, transport and disposal nuclear waste, as well as oversees whether nuclear energy is usedonly for peaceful purposes. Less reliable nuclear power plants are decommissioned and closed, and the new facilities have significantly elevated levels of operational safety.

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