Types of radiation damage. Acute radiation sickness. Acute local radiation damage.

As. Nestulia K.I.

Acute radiation sickness

- **ACUTE RADIATION DISEASE -** a nosological form that develops with external gamma and gamma neutron irradiation at a dose exceeding 1 gray (Gy) (1 Gy = 100 rad), obtained simultaneously or for a short period of time (from 3 to 10 days) , as well as when ingesting radionuclides that create an adequate absorbed dose.

- **ARS** from uniform irradiation is a typical clinical variant of radiation damage under the action of gamma-neutron radiation of an aerial nuclear explosion, as well as gamma-irradiation while in an area contaminated by the products of a nuclear explosion. For irradiation in the center of the explosion in the open and the relative distance from the radiation source and in the area of the radioactive cloud is characterized by a relatively uniform effect of ionizing radiation, the dose difference for which for different parts of the body does not exceed 2.5-3 times. Uneven irradiation is created by increasing the proportion of neutrons in the total or dose when shielding individual parts of the body.

- Clinical manifestations of ARS are a final stage in a complex chain of processes that begin with the interaction of ionizing radiation energy with cells, tissues and fluids of the body. The primary action of radiation is realized in physical, physicochemical and chemical processes with the formation of chemically active free radicals (H +. HE-, water), which have high oxidizing and regenerative properties. Subsequently, various peroxide compounds (hydrogen peroxide, etc.) are formed. Oxidizing radicals and peroxides suppress the activity of some enzymes and increase others. As a result, secondary radiobiological effects occur at different levels of biological integration

- **Disorders of physiological** regeneration of cells and tissues, as well as changes in the function of regulatory systems are of major importance in the development of radiation damage. Great sensitivity to the action of ionizing radiation of hematopoietic tissue, intestinal and skin epithelium, spermatogenic epithelium. Less radiosensitive muscle and bone tissue.
- High radiosensitivity in physiological, but relatively low damage in anatomical terms is characteristic of the nervous system. The discrepancy between the amount of absorbed dose and the magnitude of the biological effect can be explained by the violation of the regulatory functions of the central and autonomic nervous system, and not only the direct, direct effect of radiation on tissues and organs. Morphological changes in various systems and organs, most pronounced during the height of the disease, are mainly dystrophic and destructive.

Клінічна форма	*Доза, Гр*	*Ступінь важкості*	*Наслідки (прогноз)*
Кістково-мозкова форма перебігу	1-2	легка (I)	Абс. благоприємний
	2-4	середня (II)	Від. благоприємний
	4-6	важка (III)	Сумнівний
	6-10	вкрай важка (IV)	***Несприятливий***
Кишкова	10-20	вкрай важка	***Летальний, на 8-16-у добу***
Токсемічна (судинна)	20--80	вкрай важка	***Летальний, на 4-7-у добу***
Церебральна	більш 80	кр. важка	***Летальний, на 1-3–у добу***

- In the range of doses from 1 to 10 Gy develops a bone marrow form of OLB with a predominant hematopoietic lesion of varying severity. At extremely heavy defeat (a dose from 6 to 10 Gy) in a clinical picture along with deep suppression of hematopoiesis there are characteristic defeats of intestines therefore some researchers designate this pathology as transitional from a bone marrow to an intestinal form.

Bone marrow form.

- Bone marrow syndrome in this form of GPC is the leading, which largely determines the pathogenesis, clinic and outcome of the disease.
- Infectious complications and hemorrhagic syndrome are mainly a characteristic consequence of agranulocytosis and thrombocytopenia.
- Depending on the values of the absorbed doses, this form is divided by severity **into 4 stages.**
- Characteristic expressive periodicity - the phase of the disease. There are 4 periods of the disease:

КІСТКОВО-МОЗКОВА ФОРМА ГПХ

Характерна виражена періодичність
- фазність перебігу хвороби.

Виділяють 4 періоди захворювання:

Період первинної реакції

Латентний період

Період розпалу захворювання

??? Період відновлення ???

- Particular attention is paid to the presence of individual symptoms of the primary reaction, the time of their appearance from the moment of irradiation, duration and severity. The symptoms of the primary reaction can be divided into four groups:
- • **dyspeptic** - nausea, vomiting, diarrhea
- • **general** - disturbances of consciousness, weakness (malaise), headache, change of motor activity, increase in body temperature
- • **hematological** - lymphocytopenia (relative and absolute), neutrophilic leukocytosis
- • **local** - change of skin, mucous membranes and other tissues in the places of the greatest irradiation.

- Of particular importance in the assessment of the primary reaction belongs to the first 3 days of blood parameters: relative and absolute lymphocytopenia is a reliable quantitative indicator for assessing the severity of radiation damage and predicting the course of the disease in the next term.

- Clinical manifestations of the primary reaction period are not only the result of direct damage to radiosensitive systems (lymphocytopenia, delayed cell division, reduction or disappearance of young forms of hematopoietic elements), but also indicate early violations of neuro-regulatory and humoral mechanisms (dyspepsia, vascular) .

- **Latent period:** after the period of the initial reaction there is a relative improvement. Stops vomiting, nausea, reduces redness of the skin and mucous membranes, normalizes sleep and appetite, improves general well-being
- Objective clinical symptoms are mild. There are instability of pulse and blood pressure, lability of autonomic regulation, moderate general asthenia, although changes in hematopoiesis continue to progress. The duration of the latent period depends on the severity of GPC: 1 tbsp. - up to 3 days, 2 tbsp. -15-28 days, 3 tbsp. - 8-15 days, 4 tbsp. - may or may not be less than 6-8 days.
- The greatest attention in the latent period should be paid to the dynamics of hematological parameters - the timing and severity of cytopenia.

- The level of lymphocytes for 3-6 days and granulocytes for 8-9 days has a crucial prognostic value. In extremely severe patients, the absolute number of lymphocytes in the first 3-6 days is 0.1x10 9 / l, granulocytes - less than 0.5x10 9 / l on the 8th day after irradiation, platelets - less than 50x10 9 / l.

- During this period, the appearance of hair removal. The maximum absorbed dose of radiation that causes hair removal is close to 2.5-3 Gy. The most radiosensitive hair on the head, chin, to a lesser extent - on the chest, abdomen, pubis, limbs. Epilation of eyelashes and eyebrows is observed when irradiated with a dose of 6 Gy or more.

- **The period of exacerbation of the disease:** the progressive lesion of bone marrow hematopoiesis reaches significant and extreme degrees. Deep cytopenia to the expressed agranulocytosis (the number of granulocytes is less than 1x10 9 / l)) forms a basis of disturbances of immunity with the subsequent decrease in protective properties of an organism and formation of infectious complications of the exogenous and endogenous nature. Violations of tissue trophism and especially the skin, intestinal mucosa and oral cavity lead to increased permeability of physiological barriers, entry into the blood of toxic products and microbes, the development of toxemia, bacteremia, sepsis. Anemia develops. Complications are mixed infectious-toxic in nature.

Thrombocytopenia and increased vascular permeability lead to the development of hemorrhagic syndrome.

The timing of the heat and its duration depends on the severity of GPC:

- 1 st. occurs on the 30th day, lasts 10 days
- 2 st. - "- on the 20th, -up to 15 days
- 3st .- "- on the 10th, -up to 30 days
- 4 st. - "- for 4-8 days, at 3-6 weeks there is a lethal outcome.

- The clinical transition from latent to the period of exacerbation occurs abruptly (except for a mild degree). Deteriorating health, decreased appetite, increased weakness, fever. The pulse which is labile at change of position of a body, small physical activities increases. Blood pressure decreases. Myocardial dystrophy is formed (attenuation of heart tones, expansion of its size, changes in the ventricular complex on the ECG). Infectious and toxic complications get a bright clinical picture: at 2 tbsp. there are changes in the nasal cavity, mouth and larynx (stomatitis, laryngitis, pharyngitis, sore throat). At 3-4 tbsp. possible ulcerative-necrotic lesions of the mucous membranes of the digestive tract and upper respiratory tract, which allows to identify the relevant syndromes: oral, oropharyngeal, intestinal. With deep agranulocytosis, severe pneumonia and sepsis are possible. Hemorrhagic complications are manifested by hemorrhage, bleeding. Bone marrow at 4 tbsp. is completely devastated.

- **Recovery period:** distinguish between the phase of immediate (immediate) recovery, ending in 2 to 4 months from the time of irradiation, respectively, in mild, moderate and severe, and the recovery phase lasting from several months to 1-3 years. In these terms the basic functions are restored, and more serious defects gain certain stability; the basic reparative processes are practically completed and possible compensatory processes are realized.
- The beginning of the phase of direct recovery occurs at the time of the patient's recovery from agranulocytosis.

КИШКОВА ФОРМА ГПХ

- The primary reaction develops in the first minutes, lasts 3-4 days. Repeated vomiting appears in the first 15-30 minutes. Characteristic abdominal pain, chills, fever, hypotension. Often on the first day there is loose stools, later possible symptoms of enteritis and dynamic intestinal obstruction. In the first 4-7 days the oropharyngeal syndrome in the form of ulcerative stomatitis, necrosis of a mucous membrane of an oral cavity and a throat is sharply expressed. From 5-8 days the condition sharply worsens: high body temperature, severe enteritis, dehydration, general intoxication, infectious complications, bleeding. Lethal outcome for 8-16 days. At histologic research of victims on day 10-16 full loss of an intestinal epithelium caused by the termination of physiological regeneration of cells is noted. The main cause of death is due to early radiation damage to the small intestine (intestinal syndrome).

ТОКСЕМІЧНА ФОРМА ГПХ

Період первинної реакції

Латентний період

Період розпалу захворювання

??? Період відновлення ???

- The primary reaction is observed from the first minutes, short-term loss of consciousness and disturbance of motor activity is possible. Severe hemodynamic disturbances with sharply expressed arterial hypotension and a collaptoid condition develop. Intoxication as a result of deep disturbances of metabolic processes and disintegration of fabrics of intestines, mucous membranes, skin is accurately shown. Impaired renal function, manifested in oliguria. **The lethal outcome occurs on 4-7 days.**

ЦЕРЕБРАЛЬНА ФОРМА ГПХ

блискавична променева хвороба

Період первинної реакції

Латентний період

Період розпалу захворювання

??? Період відновлення ???

- According to the features of the clinical picture is defined as the most acute or lightning radiation sickness. It is characterized by collapse with loss of consciousness and a sharp drop in blood pressure. The clinical picture can be characterized as a shock-like reaction with severe hypotension, signs of cerebral edema, anuria. Vomiting and diarrhea are debilitating.
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- **There are the following syndromes of this form:**
- • convulsive-paralytic
- • amive-hypokinetic
- • dyscirculatory with a violation of the central regulation of a number of functions due to damage to nerve centers.
- Fatal outcome occurs in the first 3 days, sometimes in the first hour.
- Radiation exposure in doses of 250-300 Gy or more causes the death of experimental animals at the time of irradiation. This form of radiation damage is referred to as "death under radiation".

VOLUME OF MEDICAL CARE FOR RADIATION INJURIES.

- First aid.
- First aid (namely mutual aid) for radiation injuries involves the elimination of the weakening of the initial signs of radiation sickness. To this end, the personnel of the Armed Forces immediately after the explosion to prevent the primary reaction takes from the first aid kit an individual antiemetic - RSD or etaperazine (one tablet).
- The population receives instructions on prophylactic administration of antiemetics from the headquarters of the ISGO, the first aid unit.
- If there is a danger of further irradiation (in case of radioactive contamination of the area), a radioprotective agent is taken - cystamine -6 tablets at a time.
- After leaving the zone of radioactive contamination, partial sanitation is performed.

- Treatment of acute radiation sickness strictly corresponds to its manifestations. Treatment of the primary reaction is symptomatic: vomiting is purchased with the use of antiemetic drugs, the introduction of hypertonic solutions (with uncontrollable vomiting), dehydration requires the introduction of plasma substitutes. To prevent exogenous infections, patients are isolated and given aseptic conditions (boxes, ultraviolet sterilization of air, the use of bactericidal solutions). Treatment of bacterial complications should be urgent. Until the detection of the pathogen, the so-called empirical therapy with broad-spectrum antibiotics is carried out according to one of the following schemes.

- I. Penicillin - 20,000,000 IU / day, streptomycin - 1 g / day.
- II. Kanamycin - 1 g / day, ampicillin -4 g / day.
- III. Ceporin - 3 g / day, gentamicin -160. mg / ext.
- IV. Rifadine (benemycin) - 450 mg orally per day, lincomycin - 2 g / day.
- Daily doses of antibiotics (except rifadine) are administered i / v 2-3 times a day.

When sowing the infectious agent, antibacterial therapy becomes targeted.

Treatment of necrotic enteropathy:

complete starvation until the elimination of its clinical manifestations (usually about 1-1.5 weeks),

drink only water (but not juices!);

if necessary, prolonged fasting-parenteral nutrition;

careful care of the oral mucosa (rinsing);

intestinal sterilization (kanamycin -2 g, polymyxin M - up to 1 g, ristomycin - 1.51; nystatin - 10 000 000-20 000 000 IU / day).

Platelet-derived transfusions are required to treat thrombocytopenic hemorrhagic syndrome.

It is necessary to warn once again about inexpediency of transfusion of erythromass in acute radiation sickness if there is no clear evidence for it in the form of the expressed anemia and the respiratory, heart failure caused by it.

In other words, at a hemoglobin level above 83 g / l (8.3 g%) it is not necessary to transfuse erythromass without signs of acute blood loss, as this may further exacerbate radiation damage to the liver, increase fibrinolysis, provoke severe bleeding.

Prognosis

After elimination of all expressed displays of an acute radiation sickness (bone marrow, intestinal, oral syndromes, skin defeats) patients recover. With mild to moderate lesions, recovery is usually complete, although moderate asthenia may persist for many years. After a severe degree of the disease, severe asthenia usually persists for a long time. In addition, such patients are at risk of developing cataracts, its appearance is due to a dose of exposure to the eyes of more than 300 rad. At a dose of about 700 rad develops severe retinal damage, hemorrhage on the fundus, increased intraocular pressure, possibly with subsequent loss of vision in the affected eye.

- After acute radiation sickness, changes in the blood picture are not strictly constant: in some cases there is a stable moderate leukopenia and moderate thrombocytopenia, in other cases it is not.
- Increased susceptibility to infectious diseases in such patients is not detected.
- The appearance of gross changes in the blood-pronounced cytopenia or, conversely, leukocytosis - always indicates the development of a new pathological process (aplastic anemia as an independent disease, leukemia).
- Changes in the intestines and oral cavity are not prone to any recurrence.
- Chronic radiation sickness is a disease caused by repeated irradiation of the body in small doses totaling more than 100 rad. The development of the disease is determined not only by the total dose, but also by its power, ie, the term of irradiation, during which the absorption of a dose of radiation in the body.
- In the conditions of well-organized radiological service at this time in our country there are no new cases of chronic radiation sickness.

Будьте здорові!

Дякуємо за увагу !