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Assessment of Occupational Exposure and Individual Radio-Sensitivity in People Subjected to Ionizing Radiation

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Abstract : The estimation of accumulated radiation doses in people professionally exposed to ionizing radiation was performed using methods of biological (chromosomal aberrations frequency in lymphocytes) and physical (radionuclides analysis in urine, whole-body radiation meter, individual thermoluminescent dosimeters) dosimetry. A group of 84 "A" category employees after their work in the territory of former Semipalatinsk test site (Kazakhstan) was investigated. The dose rate in some funnels exceeds 40 μSv/h. After radionuclides determination in urine using radiochemical and WBC methods, it was shown that the total effective dose of personnel internal exposure did not exceed 0.2 mSv/year, while an acceptable dose limit for staff is 20 mSv/year. The range of external radiation doses measured with individual thermo-luminescent dosimeters was 0.3-1.406 µSv. The cytogenetic examination showed that chromosomal aberrations frequency in staff was 4.27±0.22%, which is significantly higher than at the people from non-polluting settlement Tausugur (0.87±0.1%) (p ≤ 0.01) and citizens of Almaty (1.6±0.12%) (p≤ 0.01). Chromosomal type aberrations accounted for 2.32±0.16%, 0.27±0.06% of which were dicentrics and centric rings. The cytogenetic analysis of different types group radiosensitivity among «professionals» (age, sex, ethnic group, epidemiological data) revealed no significant differences between the compared values. Using various techniques by frequency of dicentrics and centric rings, the average cumulative radiation dose for group was calculated, and that was 0.084-0.143 Gy. To perform comparative individual dosimetry using physical and biological methods of dose assessment, calibration curves (including own ones) and regression equations based on general frequency of chromosomal aberrations obtained after irradiation of blood samples by gamma-radiation with the dose rate of 0,1 Gy/min were used. Herewith, on the assumption of individual variation of chromosomal aberrations frequency (1–10%), the accumulated dose of radiation varied 0-0.3 Gy. The main problem in the interpretation of individual dosimetry results is reduced to different reaction of the objects to irradiation - radiosensitivity, which dictates the need of quantitative definition of this individual reaction and its consideration in the calculation of the received radiation dose. The entire examined contingent was assigned to a group based on the received dose and detected cytogenetic aberrations. Radiosensitive individuals, at the lowest received dose in a year, showed the highest frequency of chromosomal aberrations (5.72%). In opposite, radioresistant individuals showed the lowest frequency of chromosomal aberrations (2.8%). The cohort correlation according to the criterion of radio-sensitivity in our research was distributed as follows: radio-sensitive (26.2%) — medium radio-sensitivity (57.1%), radioresistant (16.7%). Herewith, the dispersion for radioresistant individuals is 2.3; for the group with medium radio-sensitivity — 3.3; and for radio-sensitive group — 9. These data indicate the highest variation of characteristic (reactions to radiation effect) in the group of radio-sensitive individuals. People with medium radio-sensitivity show significant long-term correlation (0.66; n=48, β ≥ 0.999) between the values of doses defined according to the results of cytogenetic analysis and dose of external radiation obtained with the help of thermoluminescent dosimeters. Mathematical models based on the type of violation of the radiation dose according to the professionals radiosensitivity level were offered.

Keywords : biodosimetry, chromosomal aberrations, ionizing radiation, radiosensitivity
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