

Dose-Response: An International Journal

Volume 12 | Issue 1

Article 11

3-2014

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Recommended Citation

Jargin, Sergei V. (2014) "LETTER TO THE EDITOR: ON THE RADIATION-LEUKEMIA DOSE-RESPONSE RELATIONSHIP AMONG RECOVERY WORKERS AFTER THE CHERNOBYL ACCIDENT," *Dose-Response: An International Journal*: Vol. 12 : Iss. 1 , Article 11.

Available at: https://scholarworks.umass.edu/dose_response/vol12/iss1/11

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LETTER TO THE EDITOR: ON THE RADIATION-LEUKEMIA DOSE-RESPONSE RELATIONSHIP AMONG RECOVERY WORKERS AFTER THE CHERNOBYL ACCIDENT

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This letter to the Editor continues the topic of the Chernobyl accident and probable overestimation of its consequences started in the journal *Dose-Response* (Jaworowski 2010; Jargin 2011) within a broader perspective: the dose-response relationship after low-dose low-rate exposures to ionizing radiation. UNSCEAR (2000) Report concluded that no increased risk of leukemia related to ionizing radiation has been found among recovery operation workers (liquidators) after the Chernobyl accident. According to the UNSCEAR (2008) Report, recent studies suggest an increase in the incidence of leukemia among the liquidators; however, limitations of those studies include low statistical power, uncertainties in dose reconstructions, and internal inconsistencies that suggest potential biases and confounding factors; evidence of the leukemia incidence increase among liquidators thus being “far from conclusive”. An association between a radiation exposure and leukemia incidence among liquidators was reported recently (Ivanov *et al.* 2012; Zablotska *et al.* 2013). Participation rates were higher among “cases” than among controls (Zablotska *et al.* 2013), a phenomenon noticed also by other researchers (Cardis *et al.* 2005; Kesminiene *et al.* 2008), being probably caused by higher motivation of the cases. The patients knowing their doses were probably on average more interested in further medical examinations if a dose estimate had been relatively high. In the health care system of the former Soviet Union, thoroughness of an examination sometimes depended on a patient’s initiative. In other words, individuals with higher dose estimates were probably given on average more attention, and cared more about their health themselves. “The dose-dependent participation of self-reported pre-screening cases” was pointed out by Zablotska *et al.* (2011), which probably can occur in Chernobyl-related research of different kind. Therefore, a probability of discovering a disease without specific local symptoms such as leukemia must be higher in people with higher dose estimates. Therefore, one of the reasons why no statistically significant radiation risks were observed for chronic lymphatic leukemia

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(CLL) by Ivanov *et al.* (2012) seems to be clear: this leukemia type is often accompanied by lymphadenopathy therefore probably remaining less frequently undiagnosed in the general population.

Furthermore, Ivanov *et al.* (2003, 2012) used the “age-specific Russian male population rates” for an external comparison (Ivanov *et al.* 2003). The counterpart of the liquidators in the population - middle-aged men - have generally not been covered by medical examinations; their access to modern health care has been limited (Jargin 2013). The higher incidence of malignancies among liquidators can therefore be explained by the screening effect and the incomplete coverage of the general population by medical checkups. The main conclusion was “that the radiation-induced excess in the risk of leukemia incidence is limited on the time after exposure. In particular, it is hardly possible to observe radiation-induced cases of leukemia among Russian adult male population 15 years after exposure” (Ivanov *et al.* 2012). Disappearance of the excessive risk of leukemia 15 years after the accident was probably caused by the subsiding post-Chernobyl “radiation phobia” (Mould 2000) and diminishing attention of the study subjects to the radiation-related health problems.

Considering the above, the studies (Ivanov *et al.* 2012; Zablotska *et al.* 2013) provide no conclusive evidence of an incidence increase of leukemia due to ionizing radiation after the Chernobyl accident. At the same time, such reports give rise to the statements in some reviews about “a two-fold increase in the incidence of leukemia between 1986 and 1996 in Russian emergency and recovery operation workers exposed to external dose of more than 150 mGy” (Balonov 2013), which is not in agreement with the above-cited conclusions by the UNSCEAR (2000, 2008). For comparison, the lowest organ absorbed dose interval at which a significant increase in the frequency of leukemia among the atomic bomb survivors was reported to be 200-490 mGy (Shimizu *et al.* 1991). In the study by Ivanov *et al.* (2012), “the mean whole-body gamma radiation dose accrued over the time of recovery works” was 108 mGy. It can be seen from the Figures V and VII in the Annex A to the UNSCEAR (2006) Report that no relative risk increase for leukemia mortality and incidence was observed among the survivors of atomic bombings in Japan at least up to the dose level 200 mSv: the factual relative risk values up to 200 mSv are below the baseline, being compatible with a hormesis effect. Ivanov *et al.* (2012) made a comparison with the results of the life span studies (LSS): “The time-averaged excess relative risk per Gray (ERR Gy⁻¹) equals 4.98 for the Russian cohort and 3.9 for the LSS cohort.” However, carcinogenic potential of an acute exposure to low-LET radiation is generally considered to be higher than that of protracted or fractionated exposure: if a given dose is administered at a lower rate or is split into many fractions, a biological system has time to repair the damage, so that the total damage will be less (UNSCEAR 1993, 2006). In particular, this ten-

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dency was demonstrated for myeloid leukemia in mice (UNSCEAR 1993). Therefore, the higher leukemia risks calculated by Ivanov *et al.* (2012) compared to those among the atomic bomb survivors is another indication that the leukemia risks among liquidators have been overestimated.

In the study by Zablotska *et al.* (2013), the “ERR/Gy estimate of 2.21 (95% CI: 0.05, 7.61) for non-CLL was lower than the ERR/Gy of 3.98 (90% CI: 2.32, 6.45) for exposure at ≥ 40 years of age that can be estimated from the atomic bomb survivor data.” However, the mean estimated bone marrow radiation doses for cases were 132.3 mGy, whereas 78 % participants had bone marrow doses < 100 mGy, and 87% < 200 mGy (Zablotska *et al.* 2013). Considering the above arguments and dose comparisons, reliability of conclusions about “a significant increase in the risk of leukemia with radiation dose based on the entire study sample” (Zablotska *et al.* 2013) appear to be questionable.

In conclusion, the estimates of radiation risks after the Chernobyl accident may be subject to ideological biases. The accident was exploited to strangle development of atomic energy: the cleanest, safest and practically inexhaustible means to meet the global energy needs (Jaworowski 2010). The impact of the Chernobyl accident has been overestimated (Bradley 2013; Jargin 2009, 2011). The dose-effect relationship after low-dose low-rate exposures to ionizing radiation should be studied in large-scale animal experiments shielded from all vested interests. On the author’s opinion, further working up of Chernobyl material would not bring much for that purpose because of the biases and confounding factors, inexact dose reconstructions and the “Chernobyl victim syndrome” (Bay and Oughton 2005).

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