Dose-Response:
An International Journal
April-June 2022:1–2

DOI: 10.1177/15593258221090091
journals.sagepub.com/home/dos
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# Potential Radiological Problems in the Ukrainian War Zone and Challenges for Related Health Risks Assessments

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**Keywords**
cancer, dose response, linear-no-threshold, modeling, risk assessment, epidemiology

The seriously damaged Chernobyl nuclear power plant is located in the Ukrainian war zone. Intentional or accidental release via detonation of radionuclides from the plant site could pose serious health risks to the nearby population. Cancers in different organs are the main risk of concern for low radiation doses; however, the manner of assessing cancer risks is now controversial in that the linear-no-threshold (LNT) model used by epidemiologists (e.g., [1,2]) contradicts current knowledge of the chemico-biological interactions[3] that occur in the body after low radiation doses and also promotes radiation phobia.[4] Which other model to use is unclear. The previous *Low Dose Radiation Research Program* in the United States that partly focused on radiobiological research that was linked to improving health-risk-assessment approaches was unfortunately canceled about 10 years ago. In establishing an approach to use in addressing health risks for low radiation doses to humans, researchers need to take into consideration that unlike animal-studies data, epidemiologic-studies data for humans are very noisy (wider stochastic error distributions) [5] so that any risk estimates generated using such data likely involve large errors.[5,6] Animal-studies data with smaller errors (for radiation doses and biological effects) than epidemiologic-studies data could be used in improving modeling methods employed in epidemiologic studies and in testing reliability of cancer risk predictions for low radiation doses.

Regarding the risks of specific life-threatening deterministic effects of large radiation doses (unlikely to occur for most individuals in the Ukrainian war zone), the acute lethality and morbidity risks can be approximated using endpoint-specific, nonlinear, *hazard-function (HF)*[7] *models*. These models feature dose and dose-rate-related thresholds and allow for external exposure to gamma radiation in combination with internal exposure via alpha-particle-, beta-particle-, and gamma-ray-emitting radionuclides. The HF models also address the complex dose-rate patterns that are associated with internal radionuclides and can be implemented using existing *computer code systems* developed in the United States and in Europe for assessing expected health consequences of nuclear power plant accidents for given populations[7]; however, parameters for the endpoint-specific HF models were estimated using *deficient data* that were available at the time the models were developed (i.e., prior to 1995). Thus, parameters for endpoint-specific HF models need to be updated using now-available data and the updated parameter estimates (and related uncertainties) need to be incorporated into computer codes used in assessing risks (and related uncertainties) of radiation deterministic health effects that include specific morbidity types and lethality modes.

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Received 3 March 2022; accepted 4 March 2022

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