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nuclear science and technology

International Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry (Low Dose Risk)

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Final report (summary)

Work performed as part of the European Atomic Energy Community's research and training programme in the field of nuclear energy 1998-2002 (Fifth Framework Programme)
Generic research in radiological sciences

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Background

Current protection standards for environmental and occupational exposures to ionising radiation are mainly based on estimates of radiation-induced cancer risk derived from studies of atomic bomb survivors in Hiroshima and Nagasaki, Japan. The use of data from populations who have received comparatively high radiation doses over short periods to predict carcinogenic effects in populations receiving generally lower doses over longer time involves uncertain extrapolations.

In order to obtain precise direct estimates of radiation-related cancer risk following protracted low doses of ionising radiation risk of cancer and thus to strengthen the scientific basis for setting radiation protection standards, the International Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry was set up, using a common core protocol. This study covers over 600 000 individually monitored workers from 17 countries (Australia, Belgium, Canada, Finland, France, Germany, Hungary, Japan, South Korea, Lithuania, Russia, Slovak Republic, Spain, Sweden, Switzerland, UK and USA).

The specific purpose of the study is to provide data for comparison with the risk estimates derived from studies of persons having received high-dose/high-dose-rate exposures. This provides a direct test of the adequacy of the extrapolation models used currently for radiation risk assessment and for the setting of radiation protection standards, and may assist in the construction of improved risk assessment models.

Objectives

The current contract was for the conduct of additional, complementary work to improve the risk estimates and maximise the information from the International Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry, a study partly funded by the Nuclear Fission Safety and INCO-Copernicus Programmes of DG Research of the EC under the Fourth Framework Programme. The project consisted of four major complementary work packages:

- the co-ordination of the international study (work package 1);
- the implementation of methods to improve the estimates of radiation-induced cancer risk from the international study by taking into account errors in dose estimates (work package 2)
- the international analyses of the data from the international study to derive direct risk estimates of the effect of low-dose protracted exposure, from the combined data, using different models of risk and taking into account errors in doses and heterogeneity (work package 3);
- formal comparison of the resulting estimates with risk estimates derived from high-dose, high-dose-rate studies (work package 4).

Brief description of the research performed and methods/approach adopted

All of the tasks foreseen in the concerted action have been carried out, although the timescale had to be prolonged because of the difficulties in finalising the data clean-up in many of the participating countries.

Work package 1 involved assistance to national collaborators in the collection and analysis of the national data sets; reception, validation and updating of data at the international level; development, implementation and installation of software for the international analyses; and co-ordination of publications on the international study.

Work package 2 involved the quantification of errors in doses as well as the development and implementation of statistical methods, relying on Monte Carlo simulations, to take these errors into account in the risk estimation process. All sources of errors in doses were reviewed through studies of historical practices and technology used in the facilities under study. Particular emphasis was put on the quantification of errors related to dosimetry technology and radiation fields in the study facilities. Following a review of dosimeters used in the participating facilities, experiments were set up to evaluate the energy and geometry response of 10 representative types of dosimeters. This information was then used to assess the response of each of the dosimeter types used, historically, in the participating facilities. Evaluations of radiation fields in occupational settings were also carried out in order to determine the energy and geometry of exposures resulting in average doses in nuclear power plants and mixed-activities facilities. This information was then combined with the energy and geometry response of the dosimeters to evaluate the extent of bias in doses, by facility and time period. A distribution for these biases was postulated and a method developed to take them into account in the risk analyses.

Work package 3 involved the investigation of the association between cumulative radiation dose and mortality from a number of different causes (all cancers, leukaemia, and other specific types of cancers) in the individual cohorts. The combined data-set as well as the direct estimation of the effect of low-dose protracted exposure on the risk of all cancers excluding leukaemia and leukaemia excluding chronic lymphocytic leukaemia were derived, from the combined data, using different models of risk.

Analyses were restricted to workers whose predominant dose was from “higher-energy” (300-3000 keV) photon radiation as doses from other types of radiation (lower-energy photons, neutrons, internal contamination) have not always been monitored adequately due to limitation of dosimetric technology in the early years of the industry. Data from Germany and Russia were not included in these analyses as they did not fulfil the criteria established a priori for inclusion in the international analyses.

Work package 4 was the formal comparison of the resulting estimates with risk estimates derived from atomic bomb survivor studies in order to assess the adequacy of the bases used currently for the establishment of radiation protection recommendations for low-dose-rate chronic exposures to low-LET ionising radiation. The risk estimates derived from the worker studies were compared with estimates derived by the consortium using the atomic bomb survivors data, restricted to males who were between the ages of 20 and 60 at the time of the bombing; this is the population which is the closest to that of the nuclear workers in the study (the number of female workers is, in fact, quite small in most of the cohorts). Further comparisons were made with the latest estimates from UNSCEAR.

Main achievements (absolute and relative to expectations)

This concerted action has, together with the previous contracts from the Nuclear Fission Safety and INCO-Copernicus Programmes of DG Research, allowed the conduct and analysis

of the largest and most comprehensive study of cancer risk among radiation workers in the nuclear industry to date.

The estimates resulting from this work are the most precise and comprehensive to date.

All activities foreseen in the concerted action have been carried out.

Exploitation and dissemination

A number of scientific publications are in preparation and will be submitted shortly for publication. It is anticipated that results from this work will be important in the upcoming evaluations of the UNSCEAR and US National Academy of Sciences BEIR committees.