EDITORIAL

Techa River studies

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Shortly after the Chernobyl accident Russian scientists, engaged in previously secret studies of populations of the Southern Urals, began to make contact with radiation researchers in Europe, Japan, and the United States. While there was some awareness of the 1957 Kyshtym accident at that time, there was no knowledge of the full extent of the occupational and population exposures resulting from the operations of the Mayak plutonium production complex. These initial contacts revealed not only the extent of these exposures, but, more importantly, that efforts had been made to define and follow fixed cohorts and to develop individual dose estimates for members of these cohorts. The study populations include a cohort of almost 20,000 Mayak workers and another cohort of about 30,000 residents of 41 rural villages along the Techa River which were contaminated by releases of radioactive material during the early years of Mayak operations. These efforts were the result of the insight and leadership of small groups of scientists working at branch laboratories affiliated with the Institute of Biophysics.

It was apparent to those who learned of the Russian research efforts that these studies of Mayak workers and Techa River residents offered unique opportunities for the quantitative estimation of human health risks associated with prolonged low dose-rate exposures. Furthermore, from the limited information available at that time it seemed likely that risk estimates based on these studies could someday provide a valuable complement to the atomic bomb survivor based, acute exposure risk estimates that form the basis for modern radiation protection standards. The Techa River cohort, which now includes about 30,000 people who lived in riverside villages during the period of releases from the Mayak complex, seemed particularly important since it was one of the few studies of an unselected population consisting of both men and women of all ages with a broad range of low dose-rate and relatively low dose exposures.

Over the past 15 years the Russian scientists involved in these studies have worked closely with scientists from the United States, Europe, and Japan in order to develop more accurate individual dose estimates, to define and refine the study populations, and to improve the quality and completeness of the mortality and cancer incidence data. The goal of these efforts is the development of credible risk estimates that provide the kind of complement to the atomic bomb survivor based estimates that were envisioned as people initially learned of these populations and the studies that were being carried out.

In recent years there has been a series of publications that provide useful, though not yet definitive, solid cancer and leukaemia risk estimates for the cohort of workers who received exposures from gamma rays and inhaled plutonium as a consequence of their work in the main plants of the Mayak complex (e.g. [1–6]). Several earlier papers [7, 8] have suggested the existence of radiation-associated increases in leukaemia and solid cancers rates among people who were exposed as a consequence of living in Techa riverside villages during the period of extensive releases. However, these papers either did not explicitly provide risk estimates or the risks that were presented were of limited usefulness due to the limitations of the follow-up.
inadequacies in the comparison groups used, or limitations of the dosimetry for Techa River cohort members.

This issue of the journal (page 17) contains a paper describing the results of a nested case-control study of leukaemia risks in Techa River cohort by Ostroumova and her Russian and French colleagues. Their study includes 83 leukaemia cases diagnosed in the Techa River cohort between 1950 and 1997 and 415 matched controls drawn from the cohort. The results indicate that the risk of leukaemia increases significantly with increasing radiation dose, with an odds ratio of 4.6 (95% CI: 1.7, 12) at 1 Gy, or, allowing for the non-linearity implicit in the exponential dose–response model used in this paper, about 2.1 at 0.5 Gy (which is the mean total bone marrow dose noted in the paper). Efforts were made to look at potential confounders and effect modifiers, though data on factors other than gender, age, and ethnicity are limited.

This paper, together with a recent paper on solid cancer and leukaemia mortality risks in the Extended Techa River Cohort [9] and another on study methods [10], provides the most comprehensive information to date on the Techa River cohort and on cancer risks and radiation exposure in this important population. These papers provide compelling evidence of radiation effects on both solid cancer and leukaemia incidence in this population and provide, albeit with some justifiable caveats, cancer risk estimates.

Despite progress in the development of a system to provide good individual dose estimates for members of Techa River cohort, uncertainty about doses remains a concern in the interpretation of risk estimates based on this cohort. The analyses of Ostroumova et al make use of individualised dose estimates based on an interim dosimetry system known as the Techa River Dosimetry System (TRDS) 96. With these dose estimates, most of the dose to the bone marrow is the result of exposure to $^{90}\text{Sr}$ deposited in the mineral bone volume with a smaller, but significant, contribution from gamma exposures arising from external exposure to radiation fields in flood plain soils and exposures arising from ingested $^{137}\text{Cs}$. Over the past decade, there has been an extensive and well-documented effort [11–13] to improve dose estimates for members of the Techa River cohort. Under the revised system, known as TRDS-2000, there is little change in doses arising from internal exposures, but due in large measure to the introduction of more realistic assumptions about the typical location of people within the affected villages, the contribution of external exposures has decreased markedly. Shortly after the descriptions of TRDS-2000 were published there was some criticism of certain aspects of the system [14], in which it was suggested that doses could be considerably higher than the new estimates. These criticisms led to the creation of an independent group of experts who reviewed the methods and assumptions underlying the TRDS-2000. This group concluded that [15] that ‘while the dose reconstruction system TRDS-2000 is basically sound, additional work is needed and the results of any epidemiological studies making use of TRDS-2000 should be qualified as preliminary, pending resolution of several issues’. In addition, recently published validation studies [16] provide some support for the TRDS-2000 external dose estimates in the upper reaches of the Techa. The Techa River dosimetry group is continuing to work to improve the basic dosimetry system and refine individual dose estimates. Efforts are also underway to assess the impact of medical diagnostic radiation exposures on risk estimates in the Techa River cohort.

The recent paper on solid cancer and leukaemia mortality risks in the Techa River cohort made use of the new TRDS-2000 dose estimates. In that work the estimated excess relative risk per Gy for leukaemia, excluding chronic lymphocytic leukaemia, was 6.5—corresponding to relative risks of 7.5 at 1 Gy (95% CI: 2.8, 25) and 4.25 at 0.5 Gy—and suggests that about 60% of the leukaemia deaths in the cohort appear to be associated with the radiation exposure. The larger risk estimates in the cohort study appear to be due primarily to the difference in TRDS-96 and TRDS-2000 external exposure dose estimates.
While none of the current risk estimates are definitive, the recent papers indicate that analyses of the Techa River cohort data are beginning to provide useful quantitative risk estimates and, with improvements in dosimetry and follow-up and further careful analyses, these data can be expected to be increasingly important in the quantification of low dose and low dose-rate risk estimates that are of primary interest in the development of radiation protection guidelines.

References

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